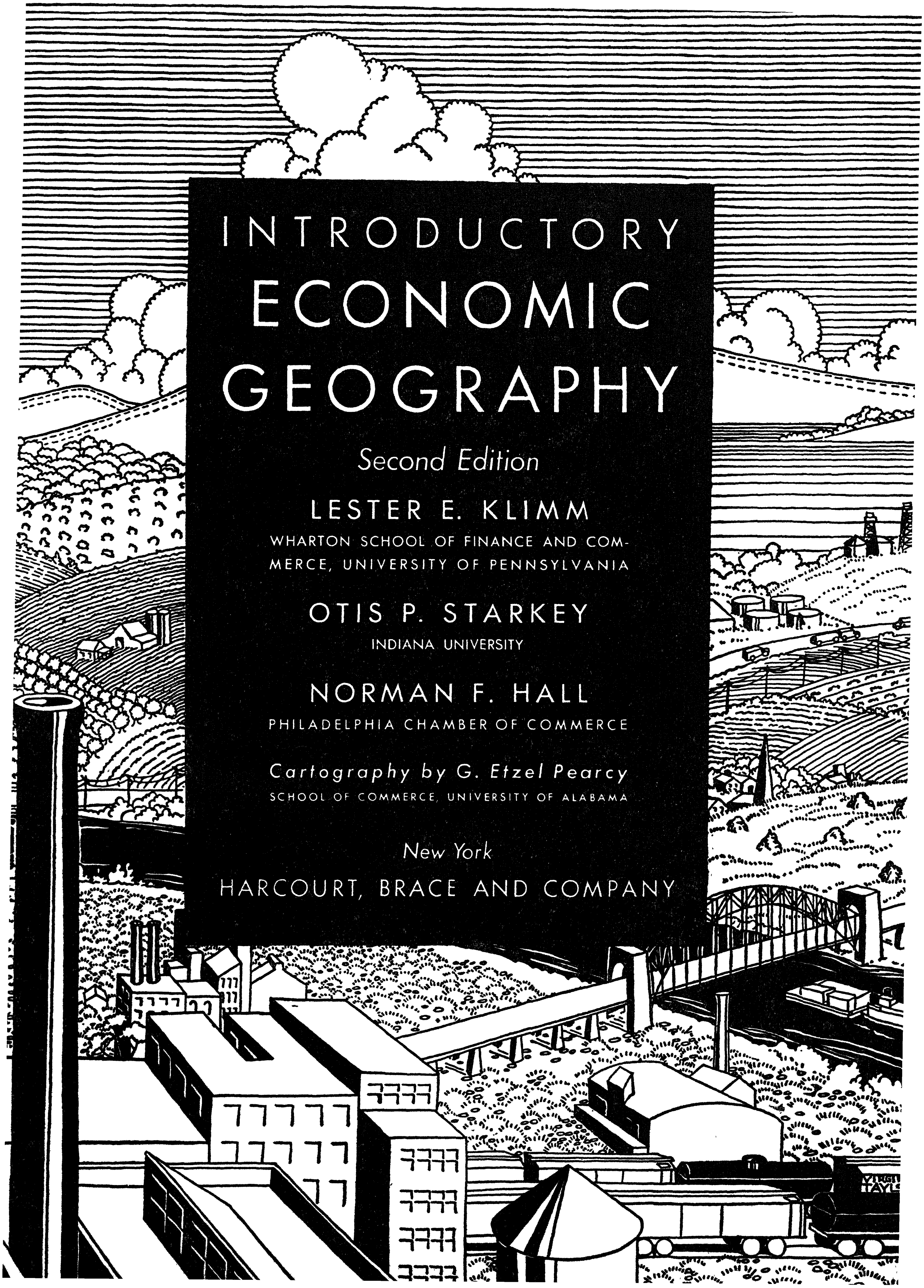

INTRODUCTORY ECONOMIC GEOGRAPHY

Second Edition

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PREFACE

Introductory Economic Geography has a comprehensiveness unusual in texts in its field. The authors consider it advisable to have a superabundance of text, maps, and charts from which the instructor can choose the materials most appropriate for his course. With such a book, he is able to adapt his assignments to the needs, interests, and previous training of his students. An examination of the table of contents and of the text will reveal that this volume is inclusive enough to serve economic geography courses that stress products and industries, those that stress an economic description of the world by regions, as well as those that emphasize the economic aspects of the physical environment.

Preceding the material on products, industries, commerce, and regions is a survey of those basic geographic relationships and elements of the earth sciences that are a necessary starting point for sound geographic study. Too often introductory courses have attempted to teach economic geography without including this essential basic information. Even if the students have already had a course in physical geography, they will find it advantageous to have this basic material available for reference. Ten years of experimentation with a required freshman course at the Wharton School have resulted in a selection and arrangement which, in the authors' opinion, provides adequate introductory material while, at the same time, allowing the principal emphasis to be placed on the phenomena of economic geography.

The Second Edition. Those familiar with the first edition of this text will recognize at once that this revision has been thorough in every respect. Although the outline, with a few exceptions, remains the same, the details have been revised wherever the experience of the authors and the criticisms of other teachers indicated that change was desirable. Scarcely a page remains unchanged. Several chapters have been either shortened or expanded, and several lengthy and difficult chapters have been divided. Additional plates and text have been added, but a reduction in the size of the climatic charts and the elimination or shortening of certain unnecessarily long portions of the text have permitted these innovations without materially lengthening the book. The world maps have been enlarged and brought up-to-date; the majority of regional maps have been redrawn as physiographic diagrams. The authors wish to call special attention to the many additional contour maps, including two plates in the original colors.

Outline. The book is divided into five parts. *Part One, Introductory,* presents a general analysis of the interaction between man and his physical environment, a statement of some of the major facts and problems of economic geography, and, of especial importance, a description of maps and other tools needed by the elementary student of economic geography. *Part Two, ~~The Physical Environment,~~* is a brief but adequate treatment of selected parts of the earth sciences. The material presented is sufficient to enable later distributions to be grouped and analyzed causally, a technique that helps give meaning to both physical and commercial facts. *Part Three, Foods, Raw Materials, and Fuels,* studies the distribution of the production

and consumption of the principal articles of commerce. They are considered both in their importance as commodities, as such, and in relation to the lives of the men who produce, trade, and consume them. *Part Four, Commerce and Manufacturing,* analyzes the geographic basis of commerce, and the cities and manufacturing that are so intimately related to commerce. *Part Five, Regional Geography,* is an analysis of the total world picture of economic geography, region by region. While much of the material presented in the previous parts is reviewed incidentally, rarely is it repeated in detail. Each continent is studied both as a whole and in its regional subdivisions. *Part Five* is intended primarily to integrate the various materials studied previously, showing their interrelations in the desirable whole of world economic geography. Moreover, this material, incorporating concise statements of background in economic history and worked out in terms of regions and nations, acquaints the student with those geographic realities with which he will normally deal throughout life. It may be noted further that the recapitulation of material in this last part is only an extension of a procedure of reviewing earlier parts which is followed throughout the book. It is believed that this pedagogical device will enable the student to consolidate his knowledge and to learn to study geographical problems from a variety of viewpoints, each of which is useful according to the nature of the problem to be solved.

Chapter Organization. Each chapter is developed around an outline suggested by the headings and subheadings. The approach to the subject matter of each chapter has been varied intentionally not only to stimulate interest and to allow for a broader presentation of general problems, but also to permit a more accurate account of each commodity, region, or topic. What is of major importance in one chapter is obviously subordinate in another chapter. It has been the intention to keep each chapter within limits suitable to a single assignment. Often it may be desirable to assign less than a full chapter and always the chapter is organized so as to allow partial assignments.

Questions. The *Questions for Discussion* which occur after each of the three chapter subdivisions are intended to present problems that arise from the foregoing material, and in every instance an effort has been made to pose those problems that are likely to be current and to contain a motivation in the student's personal interest. These questions are not designed to test the student's knowledge of the material, and, therefore, may be disregarded by the teacher who prefers not to use them for the purpose for which they were intended. At intervals a second type of question occurs under the heading, *Review Questions.* These list the most essential terms in the preceding chapters and suggest important points for review. Since they emphasize only selected, although basic, pieces of information, the student should not get the impression that they sum up all the important points of the book.

Maps and Graphs. The large page size of this text was selected to permit the use of larger and more legible maps and graphs. This more adequate page size also permits the placing of the maps and graphs where they best relate to accompanying text material. All maps are horizontal on the page, a decided reading advantage. While the student may well be encouraged to purchase a good atlas for further map study, it must be recognized that such a purchase involves an expense burdensome to many students. Those students will find that the maps included in this text constitute an unusually

complete substitute for an atlas of physical and economic geography. Access to a small commercial atlas for occasional use is all that is necessary in addition.

Photographs. The half-tone plates have been prepared with great care to illustrate some of the major geographic relationships. No pictures have been chosen merely for decoration; each has its integral function in the text. Except where necessary for contrast, obvious pictures have been omitted. Every picture should be studied carefully. For many of the plates the authors have provided a partial analysis which should suggest the sort of information obtainable from the study of photographs.

Statistical Appendix. The statistical tables, designed to furnish a basic summary of commodities, occupations, resources, and countries, supplement the similar materials in the text and may, if time permits, be further enlarged from such sources as the *Foreign Commerce Yearbook.* The authors encourage the constant use of statistics to document generalizations.

Bibliography. No attempt has been made to furnish an exhaustive bibliography or to list any considerable number of the sources that have gone into the making of this book. The list is suggestive but, it is hoped, of real functional value to the student. Quotations have not been extensively used in the text; where they occur they are intended to furnish a clue to the particular nature of useful material that the cited book contains.

Adaptability to Varying Course Requirements. *Introductory Economic Geography* contains fifty-four chapters, a convenient number for courses meeting two hours a week over two semesters. If a larger number of hours is available, it will be advantageous to spend more than one hour on those chapters which are most difficult or of greatest local interest. Much extra time can be devoted to the further analysis of the maps, graphs, and photographs. If possible, a few museum or field trips should be included in the course. If less than sixty hours are available, chapters should be omitted since it will be found extremely difficult to cover more than one chapter in a class hour. The chapters omitted should be selected from Parts Three and Five unless the students have covered the equivalent of Parts One and Two in preceding courses.

Although *Introductory Economic Geography* was designed to fit a course outline similar to the chapter outline, there are several other outlines which may be used with equal success. Three alternative outlines are suggested below:

1. A course emphasizing the regional approach. Assign Parts One, Two, and Four of the text, allowing one class hour per chapter. During the rest of the course, assign one-half or one-third of a chapter from Part Five for each class hour. Supplement this regional material with related material from Part Three; for example, a regional assignment on the first half of Chapter 41 (The South) might be supplemented by pages 183-87 on cotton.

2. A course emphasizing commodities and industries. Assign Parts One and Two, allowing one class hour per chapter. During the rest of the course, assign one-half or one-third of a chapter from Parts Three and Four. Supplement this by assigning related illustrative material in Part Five; for example, an assignment on wheat (pages 146-151) might be supplemented by pages 338-39 (wheat belts of North America), 373-74 (Pampas), and 464 (Australia).

3. A course emphasizing climatic regions. Assign Chapters 1 to 12, allowing one class hour per chapter. During the remainder of the course, devote from two to four class hours to each of the climatic regions described in Chapters 13 and 14. Supplement this material by relevant assignments in Parts Three and Five. Part Four might be appropriately assigned with the marine west-coast climate. The

following assignments on the tropical rainforest indicate how this material may be combined:

a. Tropical rainforest climatic region as a whole, pages 99-103
b. Rubber, pages 193-98
c. Other crops, pages 144-45, 151-52, 211-13, 363-64
d. Several regional examples selected from Part Five, such as pages 379-81 (South America), 434-35 (East Indies), and 476-77 (Africa)

In the outlines suggested above, the apparent disadvantage of skipping around in the text is in practice a pedagogical advantage because it trains the student to look for material relevant to the subject assigned for study.

Relations with Other Subjects. An unusual amount of material from other social sciences has been woven into the text. Material drawn from economic theory occurs throughout the text but special attention to the relations between geography and economic theory is given in Chapters 2, 3, 16, 18, 20, 21, 26, and 35. Historical references are frequent, including many paragraphs on the economic history of industries, countries, and regions—for example, pages 122-23, 200-04, 293-96, 327-28, 393, and 405. Political geography must necessarily enter into economic geography and references to political factors occur in almost every chapter—for example, on pages 18-19, 22-23, 70-75, 124, 132-35, and elsewhere. Likewise material drawn from sociology and anthropology is fairly common. This material from other sciences is, however, rarely introduced for its own sake but rather to provide a basis for more thorough geographic analysis. The teacher who wishes to do so may use this material to correlate geography with other social sciences and thus develop, in the minds of his students, a more balanced and accurate picture of the world and its peoples.

Acknowledgments. It is difficult to express adequately the gratitude and indebtedness of the authors to the many persons and institutions that contributed ideas, information, and illustrations to this book. Wherever this material has been used in the form for which the original owners were responsible, due acknowledgment has been made on the same page. Dr. G. Etzel Pearcy drew the maps and graphs not credited to other sources. Mr. Philip Taylor assisted Dr. Pearcy with many of the maps and graphs. Mrs. Taylor designed the title page for this edition.

While this text was in preliminary form, it was used in class by Professor F. E. Williams, Dr. W. F. Christians, Dr. Pearcy, and the authors. Many improvements resulted from suggestions arising from this classroom experience. The manuscript was also read by Professors W. O. Blanchard (Illinois) and A. S. Carlson (Dartmouth), who offered many helpful suggestions.

Important suggestions for the second edition were received from Professors H. C. Amick (Tennessee), Meredith Burrill (Oklahoma A. and M.), H. F. Becker (Florida State College for Women), R. E. Crist (Illinois), Eric Faigle (Syracuse), S. B. Jones (Hawaii), G. E. Pearcy (Alabama), R. M. Lovejoy (Tulsa), and J. F. Bogardus (Pennsylvania). Professor F. E. Williams, Drs. Kurt Woerner and W. F. Christians, and Messrs. H. E. Michl, W. G. Cunningham, and R. M. Ney (all from the University of Pennsylvania) have read over parts of the galleys and made numerous suggestions.

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April 3, 1940

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Part One: INTRODUCTORY

CHAPTER 1

GEOGRAPHY AND MODERN ECONOMIC LIFE

ECONOMIC GEOGRAPHY may be defined as *the study of the distribution of economic activities and ~~their relations~~ to their physical environment.* The distribution of man's economic activities can be shown through maps which any student can understand after a little study. But the extent to which the relations of economic activities to physical environment become apparent varies both with the nature of the activity and the experience and discernment of the student.

The farmer, for example, needs no textbook to demonstrate that his economic life is directly bound up to the physical environment. He knows that climate, soil, and degree of slope are of utmost importance in determining the use he shall make of his farm. He knows the significance of its location in terms of the cost of getting his goods to market and of getting the things he buys from the places where they are produced. He also knows that his effective environment is not limited to that which he can see from the top of the hill back of the house. He need only turn on his radio to learn, for example, that wheat prices are down because of favorable weather in Russia, or that corn prices are up because cattle prices are rising as a result of a drought in Argentina.

However, in the United States only 25 per cent of the people live on farms, and from them come probably an even smaller percentage of college students. Most of the readers of this book were brought up in urban surroundings where the relations between economics and physical environment are largely concealed by a highly organized system of exchange. The realities of production, finance, and distribution are further concealed from the average undergraduate because he has been primarily a consumer. As such, he is somewhat like the naïve young lady to whom the ideal solution of all her economic problems was to "marry a man with a good job and live upstairs over a delicatessen."

But back of the "good job" are such complexities as the nature and training of the man and the occupational opportunities of his community. Back of the multitude of goods on the shelves of the delicatessen are all the lands and occupations of the world. Dates come from the oases of northern Africa, salt cod from the Grand Banks off Newfoundland, and a breakfast food is manufactured at Niagara Falls from wheat grown in the Dakotas. Each exemplifies, in widely divergent parts of the world, a solution of the problem of making a living within the possibilities offered by the environment.

The economic importance of the relationships between man and his physical environment is often concealed from the consumer. If he lives on Manhattan Island, there is no item in his budget entitled, *Costs Due to Living on a Crowded Granite Island Having Hot Summers and Cold Winters,* yet he pays such costs whenever he settles a bill for housing, heat, light, food, clothing, taxes, transportation, or almost anything else. Let him but keep the same income and move to the southern tip of Florida, and he might set up an account called, *Savings Due to Moving to a Flat, Limestone Peninsula Having Warm Weather throughout the Year.*

Once the student enters business and becomes engaged in production, distribution, or finance, he is more clearly aware of the relations between economic activities and the earth upon which they are conducted.

He will encounter these relations first in terms of cost. To discover its determining factors he will have to see further than just the dollars and cents on his cost schedules

For example, the manufacturer of cotton textiles in New England not only wants to know how much he pays for his labor; he also wants to know how much his competitors in North Carolina, England, and Japan pay, and why their rates are lower. Analyzing these differences to discover how he can lower his costs, he finds that one of the major causes of varying wage levels is the contrasting physical environments.

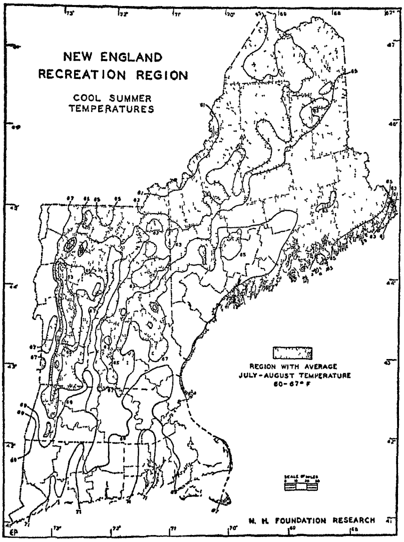


Figure 2. The tourist trade of New England is an adjustment to both the mountains and the cool summer temperatures. (From "New Hampshire Air-Conditioned by Nature," a pamphlet of the New Hampshire Foundation.)

Thus, the businessman is affected not only by the nature of his own immediate surroundings; he is also affected by other environments insofar as they in turn affect his competitors and customers.

To what extent does the physical environment *control* human activity? When the student first begins to speculate upon the relations between man and the earth, especially in simpler activities such as agriculture and mining, it appears to him that physical environment predetermines how man shall behave in any given region. In holding this opinion he is, historically, in distinguished company. Herodotus, Strabo, and many more recent historians and travelers, observing variations in human behavior in different environments, concluded that the environment was the direct control. But as men learned more about the world and its peoples, most students of geography came to the conclusion that, while the environment exerts a very powerful influence, it is not always so direct a control as earlier observers had thought.

Strong evidence that man frequently can decide how he will use his environment is found in his use of a region in different ways at different times. He may have increased his knowledge or changed his attitudes; the result has been a new relationship with the earth. At times man has even altered his environment to a considerable degree. The safest conclusion seems to be, then, that the earth offers a variety of possibilities from which men can choose those which seem most satisfactory at the time.

The degree and nature of social development often determine which environmental possibilities are utilized. An inherited land-holding system may either encourage or interfere with the introduction of new methods or crops discovered to be especially adapted to the local environment. An exaggerated nationalism may cause a nation without adequate variety of resources to attempt a self-sufficient economy. Here geography alone would seem to indicate that the welfare of all would be increased by greater rather than less foreign trade. On the other hand, far-sighted economic leadership may encourage a nation to specialize in those goods which it can produce most economically.

QUESTIONS FOR DISCUSSION

1. Our world-wide exchange economy makes most parts of the world fall, to some extent, within our environment. Explain and illustrate this statement.
2. From your experience, give several examples of the way your activities are adjusted to the physical environment Have your activities ever been determined or controlled by the physical environment? How?
3. What is included in the physical environment? Which aspects of the physical environment are static? Which are dynamic?
4. What items of cost due to the physical environment are included in the taxes of Manhattan Island (New York City)? What difference does it make that the underlying rock is granite?
5. A record-breaking wheat crop is harvested in Russia. Trace the possible economic consequences.

Some Applications of Geography

Geography—A Tool in Business. Geography is of interest not only as a partial explanation of the location and nature of various types of business, but also as a guide in the planning of business activity. Economic geography is a tool which points the way to the easiest and cheapest manner of utilizing the natural resources of the earth. This may be illustrated by examples selected from a few different businesses.

The railroads of the United States and Canada were built to "open up the country." The builders used the best information they had in determining

the routes to be followed. Obviously, some of the considerations motivating their choice were political, but most were based on the physical nature of the country through which the roads were to pass. This applied not only to topographic features which determined the difficulty and cost of construction, but especially to the resources of the country in soil, climate, and minerals; for these things meant agriculture and mining which, in themselves, furnished freight and attracted population which meant more freight. Today, the analyst of railroad securities takes many economic and personal factors into consideration, but he cannot ignore the fact that even a well-managed road with reasonable capitalization has little chance of success if it does not serve a country which has enough physical riches to furnish traffic.

The managements of the large bakery chains have known for some time that there was a direct relationship between the temperature and the consumption of bread and cake. One large chain has been using forecasts of temperature conditions between dawn and noon (the period within which most bakery products are purchased) as a basis for forecasting the day's sales in advance and thus establishing the amount to be baked.[1]

The Bureau of Foreign and Domestic Commerce of the United States Department of Commerce has long been studying the factors influencing foreign and domestic markets for American products. The following introduction to a survey of world markets for vacuum cleaners illustrates the market analyst's awareness of the importance of the environmental factors:

> Foreign markets for vacuum cleaners present selling problems which are quite different from those prevailing in the United States Only with a knowledge of the peculiarities and requirements of each market is it possible to obtain maximum results. In many countries furnishings associated with the need for a vacuum cleaner are used to a degree approaching the average American home, and as a result the vacuum cleaner is popular. In other parts of the world climatic conditions, low purchasing power, modes of living, endemic customs, and other causes combine to negative the demand for vacuum cleaners.
>
> Most floors in temperate climates are constructed of wood, and floor coverings are commonly used. In other areas floors of earth, stone, tile, brick, or cement predominate. Such floors are impervious to insects and are considered cooler than those of wood construction. Draperies, rugs, carpets, and upholstered furniture are not popular in the Tropics. A few fiber or grass rugs are used, but most of the homes have bare floors, which are usually cleaned daily and frequently treated with disinfectants. Wicker or rattan furniture is popular.[2]

Economic Geography in Industrial Expansion. Big business has tested the tool of geographic knowledge and found it profitable. The telephone companies study the geography of their markets and lay out their cables and arrange future building plans in those directions where geographic factors point to probable expansion. Another example is provided by the experience of a large steel corporation in 1905. Because of the westward movement of the center of population, the Midwestern market for iron and steel was increasing rapidly at the opening of the twentieth century. In the region around Detroit and Chicago, there arose a demand for structural steel and for steel for the agricultural-machinery, automobile, and other manufacturing industries. The corporation decided that a new plant was necessary; but, departing from the haphazard methods so often used in locating a new business, its engineers sought by careful calculation to find that spot where the raw materials could be most economically laid down, manufactured, and shipped in finished form to the market. The final choice of the engineers was an uninhabited area of sand dunes and swampy meadows that had shortly before been used as a desert setting for motion pictures. Here the corporation invested nearly $50,000,000 in building the new city of Gary, Indiana. The wisdom of its engineers was demonstrated by the growth of Gary's population to 16,000 by 1910 and 100,000 by 1930.

The geographic factors which led to the choice of Gary may be conveniently classified in two categories: *site* and *position*. *Site* includes the characteristics of the local environment—that is the immediate area on which the factory or city is built. *Position* refers to the location of a place on the earth's surface and is important because it often determines the relation of a site to the resources and development of the rest of the world. The advantages and disadvantages of the site are often most obvious but the position is usually of primary importance. Excellent sites with poor positions often remain unutilized; but poor or mediocre sites are frequently developed because of excellent positions.

The principal advantage of the position of Gary is its location in the midst of a tremendous steel *market*, actual and potential. Next comes *accessibility to raw materials*, such as coal, iron, and limestone.

[1] For details as to this and other examples of the influence of weather on business see H. A. Haring, "How Weather Conditions Affect Business," in *Advertising and Selling*, Feb., 1929, pp. 73, 80, 84, 89-92.

[2] W. C Becker. "World Market for Vacuum Cleaners," in *U. S. Commerce Reports*, March 18, 1929, p. 699.

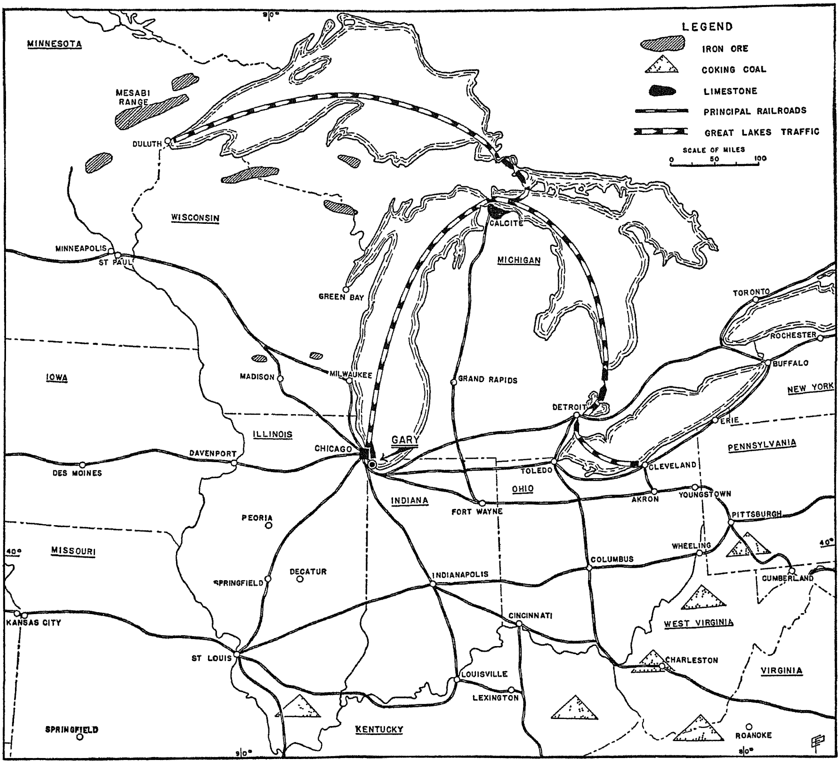


Figure 3. The position of Gary.

Iron ore can be cheaply shipped by lake steamers from the mines around the western end of Lake Superior (Fig. 3), and the coal (necessary both as raw material and as fuel) can be easily brought by rail from southern Illinois or by rail and water from the coal fields of Pennsylvania and West Virginia. The limestone can be obtained three hundred miles away at the northern end of the Michigan peninsula and brought to Gary by boat as cheaply as it could be sent thirty miles by rail. Also of importance is Gary's *crossroads position,* where one of the cheapest *direct routes* between the coal and iron ore is crossed by the important Atlantic seaboard-Chicago rail routes. Gary is near enough to Chicago so that the management can conveniently transact business with Chicago offices, yet it is far enough away to avoid the high taxes and high land prices characteristic of a metropolis. The surrounding general area contains a dense population, from which an efficient *labor supply* can be attracted to the new city.

The *position* reveals much about the potential productivity and permanency of a settlement, but the *site* is more important in laying out the city. The site of Gary includes, first, fairly level and uniform *topography,* which permitted considerable freedom in planning the city. The surrounding area is also nearly flat, so there is considerable area for expansion. The meeting of the land and water routes at Gary pro-

vides a natural position for *transshipment.* There are many such transshipment points along the shores of Lake Michigan; but since it is generally cheapest in shipping commodities to use the water route as far as possible, Gary at the extreme end of the water route has the advantage over Milwaukee, Chicago, and other points.

The adjacent lake provides an almost unlimited potential *water supply,* so that Gary's problem is to purify the water, not to find it. The underlying *geological structure* does not provide minerals or a firm foundation for skyscrapers; but minerals can be imported because of Gary's excellent position, and skyscrapers are unnecessary where there is adequate room for expansion. The *soil* is unproductive; but this is often an advantage for a city, as it avoids the necessity of paying high prices for first-rate agricultural land. Finally, the climate is stimulating, and, due to the moderating influence of the lake, it is not subject to such climatic extremes as more inland points.

This list of geographic factors may seem quite adequate to account for Gary, but it must not be forgotten that many nongeographic factors also enter into a complete explanation. Taxes were lower and industrial laws less stringent in Indiana than in adjacent Illinois; other industries had failed to utilize the area because it required millions to build a new city on an undeveloped site, but the steel corporation could command abundant capital. Such details will often receive insufficient emphasis in this text because of their transient nature. In a complete study of a current business situation, they should be examined with the greatest care.

Broader Aspects of Economic Geography. Economic geography is a tool not only to businessmen but also to students and workers in many fields of art and science. Harry Elmer Barnes uses geography as a major factor in explaining the development of Hellenic culture:

> The physical setting of Greece was a significant factor throughout the course of Greek history It is easy to overestimate the role of the natural environment, and it would be wise to bear in mind the point that environment was a conditioning influence rather than a determining factor in Greek history.
>
> In contrast to the river-valley setting of Egypt and Babylonia, the environmental situation of Greece was thalassic, that is, coastwise or seabound. The hill-and-sea environment of Attic Greece offered a fortunate combination of protection and of special facilities for commercial activity, expansion, and foreign contact. The location of the peninsula in the eastern portion of the Mediterranean —at the "threshold of the Orient"—enhanced the possibilities of cultural contact, assimilation, and commercial prosperity. The deeply indented coast-line of the peninsula is the longest in proportion to the inclosed area that has existed in the case of any important historical region. With its many natural bays and harbors and its jutting promontories, it was instrumental in transforming the Greeks into a piratical, sea-faring and sea-trading people. The promontories, straits, eddies, rocks, bays, and other coastal characteristics of the eastern Mediterranean, and of the Greek coasts in particular, favored a prosperous piratical enterprise Hiding-places were numerous and ships frequently in distress Many of the early Greek towns owed their prosperity to this activity, and Greek commerce and civilization never entirely escaped from this marauding tendency. The marked character of the coastal indentations also served to separate one region from another.[1]

Likewise, a knowledge of economic geography helps in many other fields. An understanding of the agricultural and pastoral economy of the Mediterranean region sheds much light on the interpretation of the Bible. A knowledge of climatic conditions throughout the world explains many phases in the development of architecture. The politics and manners of foreign lands often seem strange and incomprehensible because of ignorance of the geographic situation on which they are based.

QUESTIONS FOR DISCUSSION

1. Was site more important than position in the choice of Gary? Why?
2. Are the site factors likely to change in a hundred years? How? Are the position factors likely to change? How?
3. Give an example of the influence of economic geography on painting, architecture, literature, or law.
4. Analyze the advantages and disadvantages of your place of residence by listing site and position factors.

Changing Geographic Adjustments

Japan's Changing Economy. In 1835, Japan was a nation of approximately 30,000,000 people, overcrowded, largely self-sufficient, and with almost no foreign trade. The resources of the islands seemed barely sufficient to maintain the population at a low standard of living. Today, these same islands support twice as many people at a higher standard of living. The local physical environment of the country is almost exactly the same as in former times, but it is now used in a different way; and the Japanese have reached out, through trade, to bring most of the world within the limits of the environment to which they are adjusted. This may be illustrated in the case of the silk industry. The Japanese hillsides always would grow the mulberry trees, on the leaves of which the silkworm feeds; and, in fact, these hillsides were good for little else. They contributed very little to the food supply and the ability to support population.

[1] Harry Elmer Barnes, *The History of Western Civilization,* Vol. I Harcourt, Brace and Co, New York, 1935.

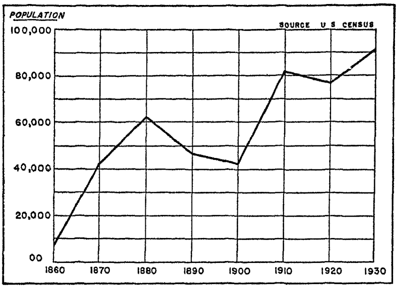


Figure 4. The population of Nevada, 1860-1930. Nevada's population fluctuates with the realization of new mineral resources and the exhaustion of old ones. Changes in mineral prices also influence mining activity and, consequently, population.

But without foreign trade the production of silk was limited to the meager demands of the Japanese market. With the rise of foreign trade, however, silk could be produced for sale abroad and the proceeds used to purchase foreign wheat or rice, so, indirectly, these same hillsides are now contributing to the feeding of a larger population. The monsoon rains have been falling on the mountains of Japan for untold centuries and running to the sea in short, but swift, rivers. With the coming of "Western ideas," these same rivers have been harnessed to furnish the water power to manufacture cloth from cotton imported from halfway across the world and sold in distant markets to pay for imported foods and raw materials. Thus, new ideas have changed the adjustments to the old local environment, and trade has allowed Japan to make adjustments to a wider environment which now includes most of the world.

The preceding discussion illustrates the dynamic and unstable nature of economic geography. Both of its two major elements, man and his environment, change; but man changes more rapidly. His changing numbers, skills, knowledge, and imagination are constantly bringing him into new relationships to the environment. Some peoples change to a greater degree and more rapidly than others, and the rate of change varies from time to time, but the change is always going on.

The Realized Environment. Rarely has man known everything about his physical environment. Even in a long-settled area, many of the minerals underground are either undiscovered or their potentialities unappreciated. Thus men necessarily adjust their activities not to the complete physical environment, but to that part of it of which they are aware. These known environmental potentialities may be conveniently referred to as the *realized environment.*

Changes in the realized environment have had revolutionary effects on human economies To primitive man waterways were barriers of first magnitude. With the invention of boats, the former barriers became highways for trade. Streams which once separated groups of men became important in bringing them together. Still later in the history of human development, streams were used for irrigation and as sources of power. Though these streams may have been approximately the same, physically, throughout history, they take on new meanings as men realize new aspects of the physical environment.

In a new land, certain elements of the environment, such as coal and iron ore, are, even if known, of relatively little use to early settlers. The same resources become of great value to their descendants at a later stage of economic development. Likewise the forest would be a handicap at first and then one of the great resources. Eventually forest products might become scarce enough to constitute a problem in conservation. It can be seen that this process of adjustment is a continuous one, and necessitates an exact knowledge of the environment and a constant search for new ways of using it.

The Changing Environment. Is the physical environment so unchanging that it need be surveyed only once during the entire course of human history? Historians and geographers are becoming more and more convinced that such environmental stability cannot be assumed, and every year they are uncovering new evidence of environmental change. For example, the famous Greek pass of Thermopylae, which was barely wide enough for a narrow road 2400 years ago, is now several miles wide. The Hwang Ho (Yellow River) of North China changed its course in 1852 and since has entered the sea north instead of south of the Shantung Peninsula. An earthquake in 1812 changed the course of part of the central Mississippi River.

The study of former lake-levels and the rings of old trees have indicated that climates in past historical periods have been significantly different from those in the same places today. Even a slight change in average temperatures and rainfall may have important effects on soils, flora, and fauna, and through them on human economies.

The changing nature of physical environment is

perceptible in our daily experiences. Each day news reports or our senses tell us of hot spells, cold waves, droughts, earthquakes, hurricanes, insect pests, and epidemics. We must adjust ourselves to these extremes rather than to the average environment which is found more often in books than in nature.

Man does much to change the physical environment. He introduces new plants and animals and, through breeding and selection, may change the nature of the original species. He destroys some species and thus upsets the balance of nature. He exhausts minerals, and whole districts decline and become economic deserts. By removing the natural vegetation, he enables running water to wash away the soil. Man is indeed a leading force in the constant change, both biological and geological, which occurs on the earth.

The Cost of Conquering the Environment. Man may overcome environmental handicaps. He may irrigate deserts, tunnel through mountains, grow plants in hothouses, and in countless other ways do things which nature seems to oppose. But it should not be overlooked that this conquest is accomplished only *at a cost.* It costs more to build roads through mountains than over plains, it costs money to build and heat hothouses. Only when the product is valuable or land is scarce, does it pay to conduct agriculture under great natural handicaps; only when the saving in distance and time is great, does it pay to tunnel through mountains rather than to climb over or go around them. In making his adjustments to the environment, man must keep in mind not only the *possibility* but also the *profitability* of a given adjustment.

Areas of Little Change. There are some areas in the world in which the changes in adjustments are few in number. They are usually regions in which the environment apparently has been too severe for man and where a very limited number of adjustments is possible. Such areas include the deserts and the arctic and subarctic regions. In them man's numbers and occupations have changed little since the beginning

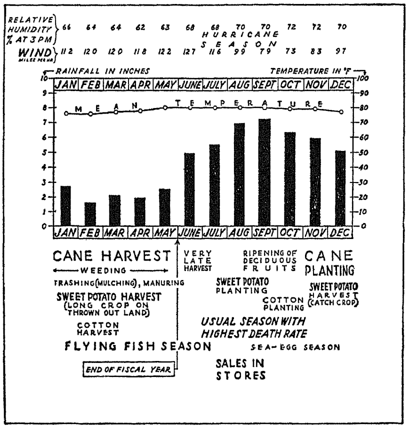


Figure 5 The seasonal distribution of economic activity in the West Indian island of Barbados. (From O. P. Starkey, *The Economic Geography of Barbados,* Columbia University Press, 1939)

of human history. This may be due to environmental limitations, or to the fact that man is weaker in intellect or cultural contacts here than elsewhere. However, it is dangerous to attribute causation to the environment, for, as in all geographic problems, both human and environmental factors as well as their interrelations must be considered.

QUESTIONS FOR DISCUSSION

1. Illustrate the difference between physically present and realized environment from your own experience when visiting a strange area.
2. Use the history of the United States to illustrate
   a. The dynamic nature of economic geography.
   b. The changing nature of the physical environment.
   c. Change in the nature of the inhabitants

Note to Readers If you haven't already done so, the authors suggest that you read the Preface. It contains several suggestions as to how to use this book most efficiently.

CHAPTER 2

THE HUMAN FACTOR IN GEOGRAPHY

THE EARTH is covered with the scars of human activity. From the air, much of its land surface appears crisscrossed with paths, roads, railways, canals, and fences. Checkerboards of furrowed fields reflect the work of the farmer; checkerboards of streets and buildings reflect urban activity, tree stumps, mine pits, and quarries reflect the continuing exhaustion of the earth's resources by man. Sometimes man adds to the beauty and productivity of nature; more commonly, he is indifferent to anything but his wants of the present and near future. All too often his viewpoint as to the use of natural resources is no broader than that of a dog seeking a bone in a garbage can; he may get what he wants, but he scatters ugliness and destruction all around. In economic geography, the dominant factor is man—consumer, producer, transformer, distributor, destroyer. He is constantly active as, in his sometimes systematic, frequently muddling, way he occupies the earth and attempts to make it serve his varying purposes.

However, man has not occupied all of the land of this planet with equal thoroughness. Of roughly 1,800,000,000 people, nearly 1,000,000,000 dwell in southeastern Asia and adjacent islands, 400,000,000 dwell in Europe; 100,000,000 dwell in eastern North America; and the remainder are irregularly scattered throughout the world. The thickly settled areas as well as the uninhabited ones cannot be attributed to any single cause. The presence or absence of a favorable environment, man's technical ability to use this environment, and the course of historical development all combine in varying proportions to explain human distribution.

Land Resources

The Carrying Power of the Land. Cattlemen know, through long experience, just how many head of cattle may be supported on a square mile of various parts of the country in average years. In the cattle business this is referred to as "the carrying power of the range." Basically, there is likewise a carrying power of the range for man, for he too must obtain food and water from the earth. Most of his requirements must be obtained near home, or at least paid for with goods or services produced there. The elements of physical environment, including position, soils, climate, vegetation, minerals, and other resources largely determine the *maximum* number of people that an area can support.

By comparing the population map of the world with maps showing the various aspects of the physical environment it is possible to make certain rough correlations. There are areas which have environmental extremes and which can only support, at the most, a sparse human population. Some areas are too cold—as Greenland, Antarctica, and the high Tibetan plateaus; some are too dry—as the Sahara Desert and central Australia; some are too rugged—as the Himalayas and the Andes Mountains. Other areas suffer from swamps, infertile soil, extreme fluctuations of temperature, and other disadvantageous conditions. Densely populated areas are found usually in favorable environments; but not all favorable environments are densely populated because man does not take advantage of all his opportunities.

The carrying power of the land, both for cattle and men, can only be stated definitely if considered in relation to the technical knowledge available at the time. For example, if an area of natural grassland produces one hundred tons of cattle food annually, it might be made to produce two hundred tons by adding fertilizers. As a result, twice as many cattle, and perhaps twice as many cow-hands, could be supported on the land. The carrying power is tremendously increased by the use of a new technique, or by realizing hitherto unused aspects of the environment.

The Carrying Power of Urban Sites. The variability of the carrying power of the land is well illustrated by urban development. Cities have grown tremendously because their favorable positions made them good places for performing a multitude of industrial, commercial, and financial services. These advantages could not be utilized until routes and ve-

hicles were developed. With the growth of modern transportation, the people who settled on the urban sites were able to exchange their services for food and raw materials. Thus, in an exchange economy, the carrying power of a site need not be limited to its food-producing ability.

The Standard of Living. Men have standards of living which vary greatly from age to age and from place to place. An area producing $20,000 worth of goods might support either 20 men on a $1000 standard, 40 men on a $500 standard or 200 men on a $100 standard. Thus in describing the human carrying power of the land, not only the manner of utilization but also the standard of living must be considered.

Standards of living vary in the nature of the goods demanded as well as in the total money spent. The annual budgets for a working-class family with two children in northern China and in eastern United States (about 1929) have been calculated as follows [1]

	Chihli, north China	*Eastern United States*
Food	$29 40	$550.00
Clothing	2.02	237.00
Rent	4.62	260.00
Fuel, light, and misc.	8.26	388.00
	$44 30	$1435.00

No doubt the figures exaggerate the difference, for prices are lower in China. Nevertheless, there are striking differences in the totals and in the proportion spent for each item. The Chinese family uses the carrying power of the land mainly to provide food. A large part of the energy of the American family is used to obtain clothing, building materials, and luxuries from the land. The more diversified needs of the American family may utilize aspects of the environment which are neglected by the Chinese.

Environmental Stimulation. Everyone knows from his own experience that certain environments are more conducive to work and pleasure than others. Thus, the environment may not only provide carrying power, but it may also stimulate human realization of the carrying power. Likewise, it may stimulate man to attain a higher standard of living.

Civilization and Climate. Dr. Ellsworth Huntington of Yale University has probably done more work than any other modern student on the stimulating

Figure 6. The effect of the seasons on factory operatives in Connecticut (solid lines) and at Pittsburgh (dotted lines). (From Ellsworth Huntington, *Civilization and Climate,* courtesy of the Yale University Press.)

effects of the physical environment. While fully appreciating the importance of nonphysical factors, he has set himself to a study of the influences of the physical environment. He attempted to test, especially, the relationship between climate and the energy and activity of people. To do this, he plotted curves showing the output of piece-rate workers in certain factories in Pennsylvania and Connecticut. After eliminating the effects of nonclimatic factors as much as possible, he then drew the curves which appear in Figure 6.

It will be seen at once that there are two peaks of production and two troughs showing low output. It appeared that the output was highest in the autumn, from the middle of October to the middle of December; was not quite so high from April through June; was low in the summer and very low in winter. He went through similar computations for the same type of workers in North Carolina, Florida, and Georgia. The shapes of the curves were very similar. From these curves he adopted the tentative conclusion that the weather of the spring months in New England was suitable for work and that the weather of the autumn months was best; the weather of summer was less favorable, and the weather of late winter the least favorable of all. He tried to check his conclusions from another direction. He plotted the death-rate curves for most of the eastern cities of the United States and found that they were the reverse of his curves of production. It seemed probable that more people die when their physical energy is at low ebb. The increased number of deaths in late winter and midsummer tended to confirm the idea that these are periods of low energy. On the other hand, the deaths

[1] Reduced to American dollars from tables in J L. Buck, *Chinese Farm Economy,* p. 385. University of Chicago Press, Chicago, 1930.

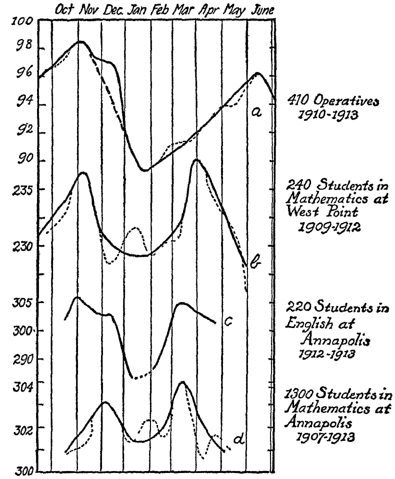


Figure 7. Seasonal variations of mental compared with physical activity. (From Ellsworth Huntington, *Civilization and Climate,* courtesy of the Yale University Press.)

were fewest in autumn and only slightly more frequent in May and June.

Huntington became convinced that a set of climatic conditions approaching those of October and November in northeastern United States were the conditions most favorable to the physical energy of man. A more detailed examination of this and of other climatic data led him to the conclusion that man was at his physical best when the *outside* temperature averaged 60° to 68° F. with from 70 to 90 per cent relative humidity. He found that a certain amount of variation around this average was more stimulating than an unchanging temperature.

His studies of the performance of students at the United States Military and Naval academies, where a daily check is kept on each student's work, indicated that the outside temperature most conducive to mental energy was considerably lower—about 40°.

Using his figures with regard to the sort of climatic conditions most conducive to physical and mental energy, he made a map of the probable effect of climate on human energy throughout the world (Fig. 8). Huntington then constructed world maps of various phases of modern civilization such as literacy, manufacturing, railroads, health, education, distribution of automobiles. All of these maps coincided with his map of climatic energy except in some details. These minor divergences Huntington explained by cultural factors such as migration.

From a comparison of these maps Dr. Huntington concluded that in general there is a direct relationship between the amount of climatic energy and the degree of civilization in the various parts of the world. This relationship, according to Huntington, is the result of a complex set of climatic influences all of which contribute to the same end. A stimulating climate influences man's wants and also his physical and mental activity in attaining these wants. It is a large factor in influencing the rapidity of human progress. However, Huntington does not claim that climate is the only cause of civilization, for he recognizes that migrations, cultural diffusion, soil, mineral deposits, position, accident, and other human and environmental factors influence the details of human advancement. Nevertheless, while recognizing many exceptions, he is convinced that climate is the major factor in explaining the distribution of civilization.

The details of Huntington's theory have been severely criticized by many investigators. Historians and sociologists have pointed out certain inconsistencies between the theory and the facts in their fields. Possibly the detailed experiments now being conducted by physiologists, industrial psychologists, and others may permit a more exact statement of the effect of climate on the human organism.[1] It seems probable that the climatic optimum for an industrial white civilization may not be the optimum for an agricultural Negro civilization. If such beliefs can be confirmed, the data will be of great value as a guide to future land utilization.

Other Theories. Other writers, including Montesquieu, Buckle, and Semple, have studied the influence of the physical environment upon man and his civilization. Miss Semple's *Influences of Geographic Environment* provides numerous examples of environmental influences of all kinds, as, for example:

> More effective than rivers in the protection which they afford are swamps. Neither solid land nor navigable water, their sluggish, passive surface raises an obstacle of pure inertia to the movements of mankind. Hence they form one of those natural boundaries that segregate. In southern England, Romney Marsh, reinforced by the Wealden Forest, fixed the western boundary of the ancient Saxon kingdom of Kent by blocking expansion in that direction, just as the bordering swamps of the Lea and Colne rivers formed the eastern and western boundaries of Middlesex.

[1] For a summary of some of these investigations, see Dill, *Life, Heat, and Altitude,* Harvard University Press, 1938.

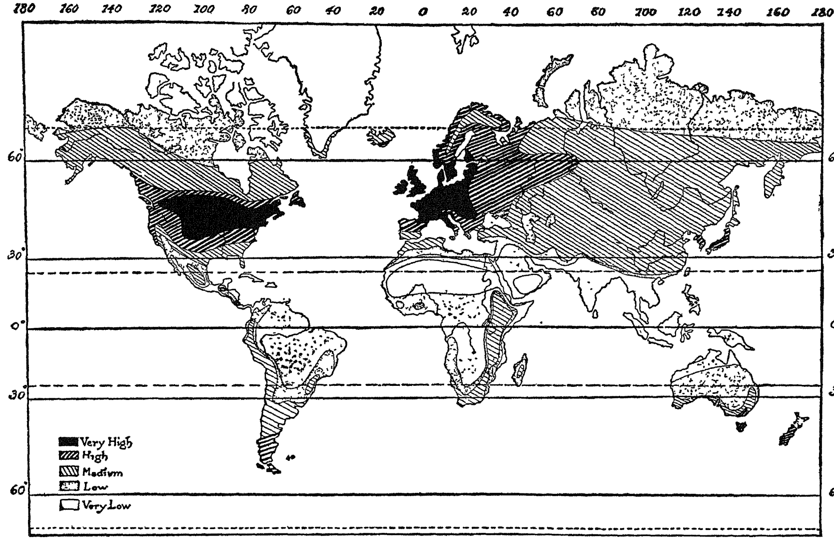


Figure 8. The stimulating effect of climate on human energy as inferred from work in factories. (From Ellsworth Huntington, *Civilization and Climate,* courtesy of the Yale University Press.)

The Fenland of the Wash, which extended in Saxon days from the highland about Lincoln south to Cambridge and Newmarket, served to hem in the Angles of Norfolk and Suffolk on the west, so that the occupation of the interior was left to later bands who entered by the estuaries of the Humber and the Forth.[1]

It is, perhaps, more difficult to measure the influence of mountains, rivers, and such features on man than to measure the influence of weather. Many of the theories advanced by Miss Semple and others, such as the influence of the desert on the development of man's belief in monotheism, can probably never be proved or disproved. It should be remembered that one or more examples of environmental influence do not prove that a given factor *always* influences man in that way. Nor do several examples of the environment's failure to influence man prove that such an environment *never* influences man. Enough data has been gathered, however, to show that environmental influences cannot be overlooked in trying to explain why a given people use their land resources as they do. The environment offers resources, often it encourages or discourages their use; and it may *suggest* how they are to be used, but it does not *determine* the use of those resources.

[1] Ellen Churchill Semple, *Influences of Geographic Environment,* p. 370. Henry Holt and Company, New York, 1911.

QUESTIONS FOR DISCUSSION

1. What bearing does Huntington's theory have on the future development of the tropics? Would air conditioning be profitable on a banana plantation?
2. How did the Japanese change the carrying power of their land since 1835? (See pages 5-6.) Explain in terms of carrying power, realized environment, site, position, and standards of living
3. Some Japanese economists claim that the Japanese have not a *lower* standard of living but a *different* standard of living from Americans. Can you suggest how they might support this statement?

Race, Culture, and Land Utilization

The history of land utilization in most parts of the world shows that the number of people and manner of utilization fluctuate widely from time to time. Only in sections with very limited resources does the land use tend to remain stable.

Many human factors must be considered in explaining the use of the land resources at a given time The analysis of any specific case is further compli

cated because each of these factors operates in combination with several or all of the other factors. Hence, the following discussion is only an outline of the principal factors to be considered and can only suggest some of the complex relations involved.

Race. The most striking differences between peoples are in the outward physical aspects which are the first and perhaps the only safe evidences of racial differences. Racial classification is based on differences in the texture of the hair, the amount of hair on the face and body, the shape of the head and nose, the color of the skin and hair, stature, and other physical criteria.

It is a common belief that race implies mental and moral characteristics, hence an area may be advanced or retarded because of the racial characteristics of its inhabitants. Scientists have not yet uncovered any positive evidence that race affects any characteristic other than the physical ones mentioned above.

It is difficult to find any *proof* of a causal relation between race and average intelligence because it has always been impossible to separate adequately the results of training and environment from native ability. If the native of the Amazon forest appears to be a slow-witted and weak individual, how is it possible to separate the portion of this condition which is due to race from that which is due to the stultifying influences of the climate, disease, isolation, lack of schools, and a host of other causes? If it is easy to make airplane mechanics out of American boys and hard to make good mechanics out of Chinese boys, is that any evidence of racial superiority? How can it be determined how far the history of the American group has given it a *cultural heritage* of farm machinery, automobiles, and engineering which prepared it for this new invention; or how far the Oriental group, plucked from a machineless farm and from a cultural environment more suited to the study of the biological sciences, was handicapped by its environment and training? Racial difference *may* have a causal meaning, but *it has not yet been proved.*

Racial differences may have important psychological implications. A Negro may be equal in ability and training to a white man, but fail to obtain an equally good position because of race prejudice. On the other hand, an ambitious Negro student may be more successful than a white student of equal abilities because the former feels he must work hard to demonstrate he is as good as the race which looks down on him.

Natural and Social Selection. Within a race there are great individual differences in ability as well as in appearance. Some of these differences are influenced by geographic conditions, through either *natural* or *social* selection. In natural selection (selection by nature), those children who cannot stand the rigors of the environment tend to die at an early age, thus the survivors are those better suited to the environment. Sometimes, especially among primitive peoples, this process is accentuated by exposing all children to various hazardous trials to eliminate the weaklings. Social selection works through marriage, for those people who are best suited to cope with the environmental and other problems of the community are most likely to be chosen in marriage and raise children. If brawn is needed, the strongest men are likely to be chosen by the belles of the community; if skill is needed, the skillful will be considered the better matrimonial catches. These forms of selection do not always work as above. Especially is this true in so-called "advanced" civilizations where social position and inherited wealth, rather than ability, are often the basis of marriage and where mental, moral, and physical weaklings are given unusual care in public or private institutions.

Selective Migration. Migrations often involve selection. A *selective* migration occurs when the group that arrives at the final destination differs in its characteristics from the group of which it was once a part in its homeland. For example, many of the "forty-niners," who sought gold about 1849, originated in New England. Only the more adventurous New Englanders tried to go to California, and generally only the stronger of these succeeded in reaching the Pacific coast. The conservatives stayed at home, the less hardy died en route or were forced to turn back. Hence, the New Englanders who reached California were, on the average, more hardy or more adventurous, or both, than those who stayed behind.

Technology. The possession of the technical skill and knowledge to use a resource is as important as owning it. A bookkeeper might own and be aware of the potentialities of a fertile Iowa farm without having the ability to exploit it. Differences in skills often account for the dissimilar development of two areas having the same natural resources. For example, Oriental rugs could be manufactured in the wool-producing regions of Australia *if* the Australians had the necessary skill and patience. But the skill is lacking and it does not pay the Australians to learn it, for Persian shepherds are willing to do rug-weaving for much less than the minimum wage required by the Australian standard of living.

The origin of many important technical discoveries,

such as the use of fire, the domestication of animals, and the cultivation of plants, is hidden in the haze of antiquity. To what extent these discoveries were due to physical environment or the inspiration of some genius or pure accident cannot be determined. The spread of these ideas and inventions is known as *diffusion* or *cultural diffusion.*[1]

Diffusion is often influenced by geographic conditions. An invention made in one tribe may spread to neighboring tribes through contact in war or trade. The spread is along routes of travel which in turn are largely influenced by the physical features of the earth. If it is carried to an environment in which it is not needed or is harmful, the diffused invention tends to die out. Such inventions may survive in conditions where they are not necessary or are useless. Occasionally, even useful inventions disappear, probably due to social factors. Thus, the environment is a determinant of what is possible, and man's imagination and adaptability work within these limits.

Productive, Destructive, and Nonextractive Exploitation. Brunhes, in his interesting book, *Human Geography,*[2] differentiates three ways of utilizing land resources. In the first, *productive* exploitation, land is used in production so as to maintain or increase its future productivity. In the second, *destructive* exploitation, the resource is being used up or destroyed. In the third, *nonextractive* or *sterile* exploitation, the land is occupied, but only as a foundation, and its soil or mineral wealth is not used. Buildings and roads are the principal forms of this last type, which is sometimes referred to as "using the land for standing room."

Many occupations may be conducted either by productive or destructive exploitation, although some must by nature be destructive, as, for example, mining. Farming is destructive when the farmer fails to maintain the fertility of the soil or permits soil erosion, plant diseases, and other harmful things to injure his land. Lumbering is destructive when the trees are cut faster than they are replaced. If the carrying power of the earth is to be maintained, it is obvious that man should engage in productive rather than destructive exploitation wherever possible.

The Stage of Economic Development. Certain uses of land resources may be ideal for a region in one period of history, but unsuitable at an earlier, or later, time. Before the development of extensive trade, occupations had to be such as to make a local area practically self-sufficient. Later, some of these occupations may die out because the commodities they produced can be obtained more cheaply by trade with other regions. New occupations may develop and old occupations may become of much greater importance because their surplus products are in demand in other regions.

Consider the economic history of eastern Pennsylvania. During the earliest stage of human history, the area was unoccupied, for it was distant from the place of man's origin. Then, tribes of hunters entered and used its most obvious resources, seeds, berries, fish, game, firewood; and wood and stones for toolmaking. Probably many centuries later agricultural techniques were diffused into this section from the south, and small clearings were planted with corn and beans. In the seventeenth century, white hunters, trappers, and traders began the white invasion. They were soon followed by pioneer farmers who farmed the valley floors and cut lumber on the hillsides. Early in the nineteenth century, with the building of canals and railroads, the mineral resources—coal, iron ore, slate, and lime—became important and, still later, with the perfection of manufacturing machinery and the growth of the eastern American market, parts of the area became industrial centers. The hunters and trappers have almost disappeared; agriculture is now providing truck and dairy products to near-by cities instead of grain for Indian tribes. Much food, such as flour and meat, is imported and even minerals are being imported to replace, or supplement, almost exhausted resources, such as iron ore. The occupations have changed greatly, yet each was suited to both the environment and the economic development of the world at the particular time the occupation flourished.

QUESTIONS FOR DISCUSSION

1. The Indians utilized the physical environment of the United States much differently than did the white colonists. Explain in terms of the preceding discussion.
2. Was the settlement of the thirteen colonies an example of selective migration? Explain.
3. How has each of the factors described in this chapter influenced the use of land near your home?

Some Geographic Characteristics of Occupations

The occupations map (Fig. 9) sums up the present result of the interaction of the physical environment and the various human factors just outlined. The

[1] Diffusion includes the spread of all human ideas and skills whether technical or not, including, for example, religious and philosophical ideas.

[2] Translated from the French. Rand McNally, New York, 1920; or Jean Brunhes, *La géographie humaine* (3d ed.). Paris, 1925.

resulting pattern on the map portrays those occupations and combinations of occupations which men in each part of the world consider most profitable.

Collecting. One of the most obvious ways of making a living is to collect various seeds, berries, herbs, leaves, roots, and stones which can be made to supply man's simplest wants. Collecting will usually support only a small number of people in a relatively large area. The supplies of seeds and other products are often uncertain or seasonal, and a nomadic or semi-nomadic life is often necessary to supply the needs of the group.

Hunting and Fishing. Among primitive people, hunting and fishing are almost invariably associated with collecting. As in the case of collecting, only a sparse population can be supported by these occupations. Often this population is concentrated near game trails or fishing grounds while large areas of intervening country remain unoccupied. Certain lands, great in area but small in value, remain in the hands of a relatively small number of primitive hunters and fishers. As these lands are needed for more intensive exploitation, they will probably be taken away from these survivors—as has been done in the past. Except for these primitive people, hunting for food rather than sport has almost disappeared. Trapping still provides a large part of the world's fur supplies, although fox, skunk, and rabbit farms are becoming increasingly important sources of supply. In contrast to the decline of hunting, ocean fishing has become a major industry and is practiced wherever shallow waters provide feeding grounds for fish.

Farming. Cultivating crops is probably an outgrowth of collecting. Perhaps it started when man began to care for the plants from which he collected, first by rooting out competing plants, and later by planting seeds and tilling the soil. Cultivation put collecting on a stable basis. Instead of being forced to go where the plants grew wild, men cultivated those plants and made the harvest more certain. From more than 140,000 species, man has selected about 300 for cultivation. With man's help, these plants now occupy a large part of the arable land.

Because it concentrates the plants that suit human wants, farming is a very efficient method of production and enables the land to support a dense population—more than 1000 per square mile in such favored areas as the Nile Valley. Such intensive utilization of the soil makes farming destructive unless the elements removed by the crops are replaced by adding mineral or animal fertilizers. Often the elements of

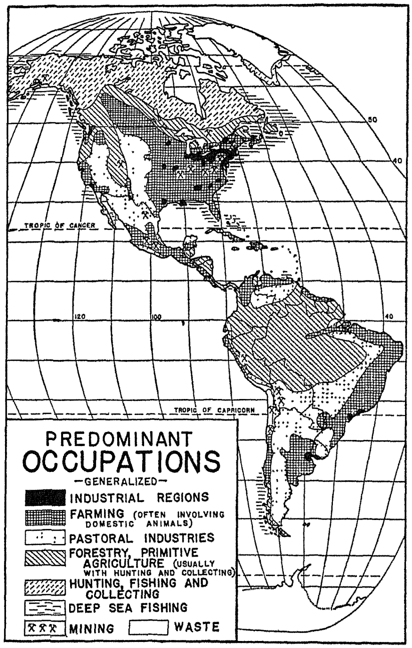


Figure 9-A.

fertility are obtained from areas where farming is not possible, for example, the nitrate fields of the Chilean deserts and the guano islands of Peru.

Domesticated Animals. The domestication of animals has replaced hunting in about the same way that tillage replaced collecting. Domestic animals are often an important part of farming. Often they use the areas too swampy, too rocky, too steep, or with too poor soil for the growing of crops. But on most farms, the food from the pasture must be supplemented by other foods, purchased or cultivated. Feeding corn that could be used for direct human consumption to animals is inefficient, for it takes from five to twenty pounds of feed to add one pound to the animal's weight. Consequently, meat is a luxury and meat animals tend to be few in number in overpopulated agricultural lands. On the other hand, in sparsely populated grasslands, domesticated animals are the main resource, for they convert grass and plants which man cannot eat, directly, into meat.

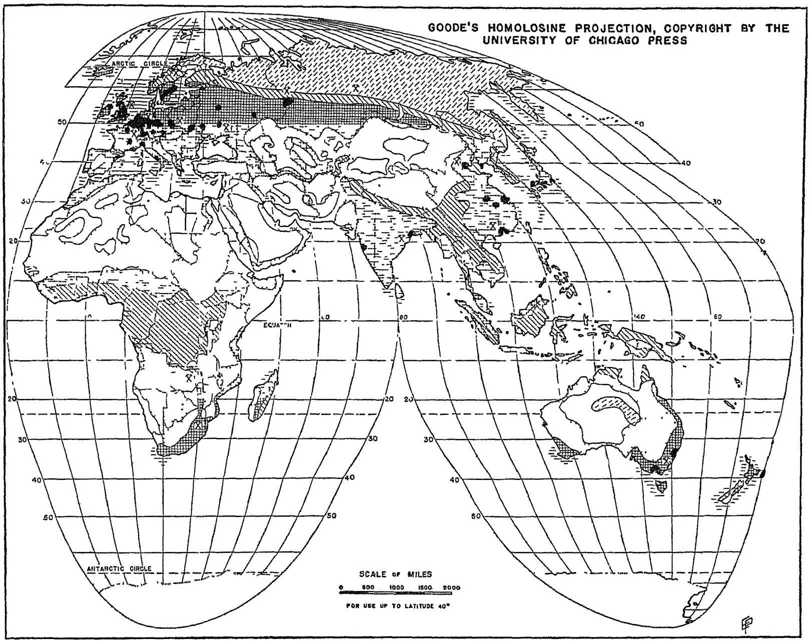


Figure 9-B.

Lumbering. Lumbering has been pushed out of the best lands by agriculture. A large part of the earth was once forest covered, and much of this wealth of lumber was destroyed to clear the land for fields. Until recently, lumbering was universally carried on as a destructive industry. Lumbermen were semi-nomadic. They set up their camps, cut down the trees, and removed the best wood. After the valuable lumber in the neighborhood was exhausted, they moved on to new forests and left the stump-covered lands to revert to the state. In time, nature would cover the land with forest, but often it took fifty to one hundred years to replace a season's cutting. Between the farmer's clearing of the land, and the lumberman's wasteful methods, most of the readily accessible virgin forests have been destroyed.

Mining and Quarrying. Minerals of almost every kind are found throughout a large part of the world. Gold, for example, although a rare metal, is widespread, and is even found in minute quantities in sea water. These minerals, however, are valueless unless they are sufficiently concentrated so as to be useful to man. Such concentrations are known as ore bodies.

Mining and quarrying are necessarily destructive forms of exploitation in so far as they deplete the stock of minerals remaining to be drawn on in the future. The use of the fuel minerals—coal and petroleum—destroys them completely; but copper, iron, gold, and other metals suffer surprisingly little loss and may be scrapped and used repeatedly.

Mining settlements are often in sections that are useless for other purposes. Many mining regions are rugged, for minerals tend to be concentrated more often in such regions; or else they are more easily discovered there. Arid and semiarid regions, likewise, may contain mining activity, for the sparse vegetation makes mineral resources more apparent and the sparse rainfall does not wash away soluble mineral deposits (for example, the nitrates of the Chilean deserts)

Since these mining sections have difficulty in raising their own food, such mineral lands cannot support a population unless there is a well-developed trade (direct or indirect) with an agricultural or pastoral region.

Commerce and Transportation. A characteristic of an exchange economy is the *geographical division of labor.* This regional specialization means that, considering any economy, the world can be divided into regions of surplus production and regions of deficit. Unless the surplus can be transported to the deficit regions, it has little value. Commerce and transportation are the principal means by which mankind attempts to equalize the supply and demand of various commodities throughout the world.

There are other services performed by commerce. No article is fully produced until it is ready for human use. This means that it must not only be in finished physical form, but that the consumer must know about it and its uses and must be able to pay for it, and that it must be where he wants it when he wants it. Wholesalers, retailers, shippers, advertisers, bankers, and other commercial agencies perform important services in getting the goods from the physical producer into the hands of the ultimate consumer.

Figure 10

THE GROWTH OF FOREIGN COMMERCE [1]

	Aggregate foreign commerce of world (billion dollars)	*Foreign commerce per capita* (dollars)	*Coal production* (million metric tons)
1700	.125		
1750	.250		
1800	1 4	2.00	11.
1820	1.6	2.00	15.
1840	2.7	3.00	41.
1860	7.2	6.00	129.
1880	14.7	10.00	308.
1898	19.9	13.00	553.
1913	41.7	21.00	1342
1929	68.3	35 00	1540.
1933	23.8	12 00	1154.
1937	31.1	17.00	1515.

Commerce on a large scale has developed only within the last two centuries (Fig. 10). Before that time, it was customary to depend on goods produced locally, and foreign goods were, for the most part, the luxuries of the rich. Today, the bulk of the goods used in the advanced nations comes from a distance, and almost all of these goods are obtained through commercial agencies rather than direct from the producers. This increase is due to many causes, of which the following are outstanding:

1. Improved methods of transportation.
2. Greatly increased production per capita, due to mechanical inventions and the increased use of coal (Fig. 10), oil, and water power.
3. Greater knowledge of the world's resources and greater use of the geographical division of labor.
4. Development of large-scale international trade and banking organizations
5. Increased governmental encouragement of trade through consular agencies and commercial treaties.

Commerce and transportation are dependent industries, for trade cannot exist unless there is something to trade in. Although trade routes are strongly influenced by such environmental factors as ease of travel and position, these routes will not be used at all unless they connect productive sites. Where trade routes come together, or where transshipment must take place, commercial centers tend to develop. The size of these centers usually depends on the extent and productivity of the area they serve (their hinterland), and any factor that harms the productivity of that area reduces the prosperity of the commercial center.

Manufacturing. The simple manufacturing of local raw materials into products for local consumption has been important since prehistoric times. The grinding of grain into flour, the tanning of leather, the making of simple stone and metal implements, are ancient industries. Complex manufacturing, such as the combination of a great variety of raw materials into automobiles, sewing machines, and similar products, could not be developed before the rise of a world-wide commerce. The raw materials had to be brought together from diverse, distant places, and the product had to be sold in far-flung markets if the economies of large-scale production were to bring the price down to the purchasing power of a great mass of consumers. Thus, both for manufacture and sale, extensive commerce was necessary.

Manufacturing often separates people from the agricultural carrying power of the land. Industrial areas have, in themselves, tremendous carrying power, but it can be used only if exchange with food-surplus regions is easy. Manufacturing regions are, therefore, in an extremely precarious economic position. If blockades, boycotts, or tariffs stop exchange, they become unable to support most of their population,

[1] Clive Day, *A History of Commerce*, pp. 270-271. Longmans, Green and Co, New York, 1907; also *Commerce Yearbook, 1930*, Vol. II, pp. 648, 672, 676; also *Foreign Commerce Yearbook, 1938*. In studying the above figures, it should be kept in mind that the earlier figures are, necessarily, largely estimates. Also the increase in trade is probably not so great in volume as in value because of the effect of increasing price levels.

hence England's fear of submarine warfare and naval inferiority, and Japan's wrath at the Chinese boycott

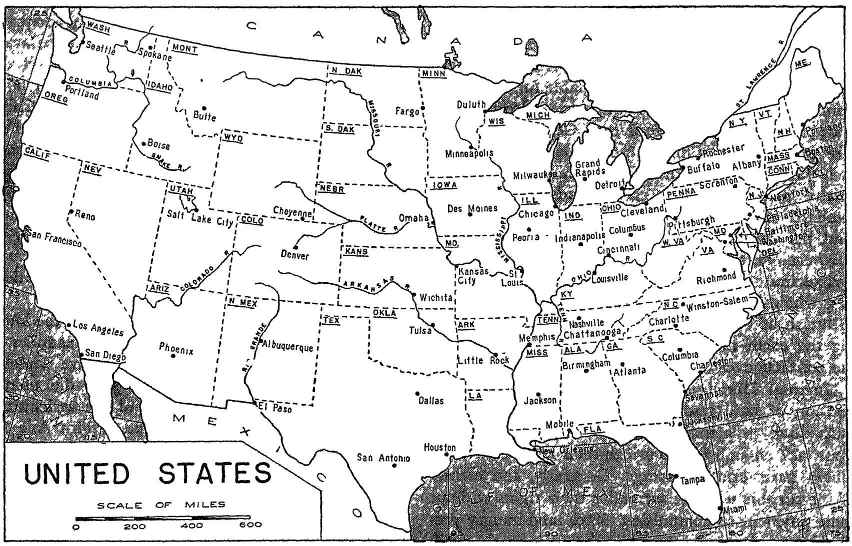
Construction Industries. Man has made numerous small but significant alterations in the earth's surface. These works have usually been performed by the construction industries and are generally of the nature of capital investments. They include the creation of small enclaves of artificial climate by erecting buildings; the harnessing of power by building dams and powerhouses; the irrigation of deserts by building canals and reservoirs, and the reduction of the friction of space by digging canals, channels, and tunnels, and by building roads, railroads, power lines, and cables.

The construction industries are tied closely to the market. Their structures are often so bulky that they must at least be assembled at the site. Whenever possible, local raw materials are used to reduce transportation costs, and frequently the design is altered to suit the available materials.

Professional and Service Occupations. A large number of people, especially in progressive countries, are engaged in occupations that have little direct connection with the carrying power of the land. These include doctors, lawyers, statesmen, clergymen, teachers, domestic servants, barbers, actors, and many others. In reality, all of these people are engaged in making the work of those in other occupations more efficient. Their prosperity is usually dependent on the prosperity of the basic occupations in the region.

QUESTIONS FOR DISCUSSION

1. Where are the principal hunting regions? Why? Are they correlated with lumbering? Why? Is ocean fishing in the middle or on the margins of the oceans? Why?
2. Where are the waste areas? So far as you can tell, what kinds of regions are they? Are the pastoral regions very productive? What evidence is there on the maps and elsewhere to support your answer?
3. Compare the population map with the occupations map. What correlations can you discover? Explain as many as you can.



CHAPTER 3

POPULATION PROBLEMS

HUMAN history is full of strife, much of which has been concerned with the ownership and use of land. Title disputes, inheritance, entail, mortgage foreclosure, taxation, squatting, inclosures, eviction, nomad raids, wars of conquest—all of these suggest numerous historical disputes over land. So, in spite of the many resources which the earth offers, these resources have been one of the major and primary causes of human struggle and discontent.

Is the Land Resource Adequate?

The land resource of the world amounts to about 33,000,000,000 acres, of which it is estimated[1] from 13,000,000,000 to 17,000,000,000 acres are arable. Assuming that the world's population is 1,800,000,000, about 9 acres of arable land is available for each man, woman, and child. This would seem adequate, for 2 arable acres suffice to feed each German, 2/3 of an acre to feed each Chinese, and only 1/4 of an acre each Japanese. Even the United States, with its extensive utilization of its farm lands and its high standard of living, requires only 13 acres of arable land per capita, of which 10 acres is pasture land. Furthermore, there is now an overproduction of some agricultural products. Apparently the land resource as a whole is adequate for the present, and the distribution of this resource among the people inhabiting the earth must be studied if an explanation of the conflicts over land is to be found.

Unequal Division of Land Resources. Unequal division of land resources, both among nations and individuals, is a major source of trouble. Many nations lack enough soil to utilize their labor efficiently; others have unused acreage. Generally, the owners of the surplus will not surrender their rights without some payment or compulsion. Since land-hungry people are usually poor, the first method is rarely available to them, hence legal or military force is resorted to.

The inequality is a matter of kind as well as amount. In the estimates given above, no distinction was made between soil which will grow forty bushels of wheat per acre and soil which will barely support a sparse grass cover. Such differences in soil cause one farmer to prosper while his neighbor with a larger farm and equal skill may earn only a meager living. Whether a given piece of land is overcrowded can only be judged if the productivity of that land is known. A square mile of land in the Corn Belt of the United States would not be crowded if it had ten inhabitants; a similar area in the Sahara Desert would be overcrowded with one-tenth that number.

Even if the land resource is theoretically adequate, sufficient sites with good positions may not be available. Much of Siberia is almost unoccupied, yet the overcrowded Chinese do not emigrate to it in large numbers. Siberia is too far away from both China and world markets to suit the Chinese farmer. Further, it is too cold for many of the present Chinese crops or methods of agriculture. In general, people tend to stay crowded where they are rather than to move to distant, unoccupied sites of which they know almost nothing. The pioneers and emigrants play an important part in world history, but they have usually been but a small proportion of the populations from which they are drawn.

Land resources may change and upset the man-land ratio. History contains numerous examples of such changes. Periods of low rainfall have depleted the pastures of central Asia and sent the nomad herders out in all directions to raid the agricultural lands of Europe and southern and eastern Asia for the means of livelihood. Scattered through the Rocky Mountains are "ghost towns" which represented booming "cities" before the exhaustion of the mineral resources that led to their establishment. In 1287 the River Rother in England changed its course after a great storm and left three of the important "Cinque Ports"—Romney, Winchelsea, and Rye—isolated from contact with the sea.

The Future Population. Even if the land resources are adequate at present, the world's popula-

[1] Robert Kuczynski, *Population*, p. 284. Harris Foundation Lectures 1929, Chicago, 1930; also O. E. Baker in same volume, pp. 219-220.

tion is growing rapidly and the resources may become inadequate. Especially serious is the fact that certain overcrowded countries, such as China, Japan, and Italy, are among the countries with high birth rates and increasing populations. Other countries with surplus resources, such as France, Sweden, and the United States, have a relatively static population or a decreasing birth rate. Thus the inequalities in resource distribution, and the consequent problems, are increasing.

Estimates of the carrying power of the land in terms of human population are extremely difficult to make because of such differences in standards of living, technology, and other factors as were described in the preceding chapter. Kuczynski estimates that the world may be able to support 10,000,000,000 people without lowering present living standards. However, this number is possible only with unlimited migration, including the removal of restriction against immigration in countries such as the United States and Australia. Without such free migration, Kuczynski estimates the world cannot double its present population.

Many students of population problems are convinced that the rate of population increase is slowing down and that the population may become static before the earth as a whole becomes overcrowded. Statistics clearly show this slowing down (Fig. 11),

Figure 11

ANNUAL RATE OF INCREASE OF POPULATION FOR SELECTED COUNTRIES BY FIVE YEAR PERIODS, 1901-35

(per cent of total population per year)

Country	*1901-05*	*1906-10*	*1911-15*	*1916-20*	*1921-25*	*1926-30*	*1931-35*
Japan	1.29	1.08	1.42	0.37	1.42	1.48	1.47
Italy	0.52	0.80	1.16	0.22	0.91	0.31	0.98
Germany	1.46	1.36	0.71	—1.62	0.73	0.42	0.55
Sweden	0.61	0.84	0.70	0.64	0.40	0.22	0.35
France	0.15	0.06	—0.72	0.55	0.76	0.53	0.05
England and Wales	1.04	1.04	—0.95	1.89	0.62	0.47	0.41
United States	2.00	1.82	1.67	1.21	1.67	1.26	0.70
Canada	2.99	2.99	2.20	1.81	1.33	1.97	1.35
Australia	1.38	2.03	1.95	1.99	2.11	1.50	0.76
New Zealand	2.86	2.56	1.61	2.32	1.95	1.25	0.92

but unfortunately the deceleration is least or is absent in those countries which need it most.

Population Theory and Political Policy. A consideration of population problems and facts such as those just presented has led to the development of numerous population theories. Whether each of these theories is true in part or as a whole is difficult to discover, for population statistics and other data needed to check such theories are far from complete for a large part of the earth. For such a large country as China, for example, the population estimates are quite unsatisfactory and vary by as much as 100,000,000. However, these theories, whether true or not, are often significant, for they have been and are being used to promote and justify political policies. If it be accepted that a growing, progressive people has a right to take resources that are poorly utilized by a retarded people, then wars of conquest can easily be justified. Such a theory was used to justify the annexation of the lands of the American Indian and is today being used to defend Italian and German expansion. If it be accepted that famine is the natural and correct way of relieving overcrowding, then it can be argued that famine relief is blocking one of nature's safety valves.

QUESTIONS FOR DISCUSSION

1. How is it possible for American farmers to suffer from overproduction when millions in China lack sufficient food?
2. Which countries sent large numbers of immigrants to the United States? Are these countries overcrowded? How would you define an "overcrowded country"?

Population Theories

The Malthusian Theory. During the eighteenth century the population of Europe increased rapidly. This was especially noted because about this time governments began to keep careful records of the number of people. The Reverend Thomas Malthus collected all the available data on population and, in 1798, published his *Essay on Population* which is largely a compilation of this data with comments and conclusions. Malthus stated the doctrine that human beings had a tendency to increase right up to the number the country would support and that the only important reason they did not increase beyond that number was that the surplus would die of starvation or disease or would be killed in war (he called these the "positive checks" on population increase).

In its mildest form, as he modified his doctrine to meet a storm of criticism, Malthus' theory was as follows:

1. Population is necessarily limited by the means of subsistence.
2. Population invariably increases where the means of subsistence increase, unless prevented by some very powerful and obvious checks.
3. These checks, and the checks which repress the superior power of population and keep its effects on a level with the means of subsistence, are all resolvable into moral restraint, vice and misery.

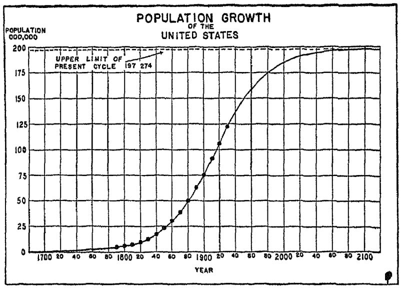


Figure 12. The past and predicted growth of the population of the United States according to Pearl. More recent estimates suggest that the upper limit will be much lower.

In his later years, Malthus became somewhat more impressed with the power of the most advanced people to improve their lot to some extent through the limitation of their numbers by late marriage and by the use of moral restraint (these he called the "preventive checks"), but he apparently did not believe that the preventive checks would be important among any considerable number of the world's people. Contraception on the modern scale was not known in Malthus' time and if it had been, he would probably have classified it as vice.

It will be seen that the doctrine of Malthus held out little hope for the improvement of man's lot even though he were to discover new and increasingly efficient means of supplying his needs. Because of the tendency for population to increase more rapidly than the food supply, only the positive checks would serve as real checks; and the population would soon adjust itself to the new productivity, and there would be as much misery as ever. The Malthusian theory and several allied theories, equally pessimistic, explain why economics was at that time referred to as "the dismal science."

Optimistic Population Theories. In answer to Malthus, there arose a number of theories that attempted to demonstrate that progress was possible. Sadler, for instance, contended that "the fecundity of human beings under similar circumstances varies inversely as their numbers in a given space." Others pointed out that the increase in man's numbers often involved an increase in the amount of food produced.

Raymond Pearl has made extensive studies of population on a statistical and biological basis. Pearl concludes that population growth follows a mathematical curve (logistic curve) such as that for the United States shown in Fig. 12, which tends to level off after a certain point is reached. The point at which the curve tends to flatten out is influenced by a number of complex factors, chief among which is crowding of population. According to Pearl, fertility of the race declines under crowded conditions and this tends toward a flattening out of the curve. There is no fixed density of population at which this trend begins to appear. It apparently varies from one country to another and with differences in techniques and standards of living. Not all populations pass through the whole regime of the curve, for new techniques may release additional supplies of food and materials and thus relieve the pressure and start the curve over again. In other words, a density of population which might be great enough to cause the rate of growth to decrease at one time may, in a new order of things, actually represent a "sparse" population in relation to the income newly made available. The most important elements of Pearl's theory are that human population follows a definite biologic law (which may be expressed in mathematical terms), and that increasing density of population leads to decreasing rate of population increase.

An Italian theorist, Gini, has advocated a cyclical theory of population growth. He believes that racial groups increase and expand at the expense of decadent groups and then gradually degenerate. An infusion of new blood may then lead to the formation of a new and healthy racial stock which will increase in numbers, talent, and power. Applying his theory, Gini states:

> We may well ask whether, in the case of Italy at least, this revival is not due to the more thorough amalgamation of the racial stocks of the several regions which has taken place on a large scale only during the last one or two generations, and which is becoming more and more general as a result of closer economic relations, greater facilities for moving about, and better reciprocal knowledge of each other acquired during the war.[1]

QUESTIONS FOR DISCUSSION

1. How do the rates of population increase (Fig. 11) compare with the density of population as shown in the appendix tables? What factors may account for the changes in rates of natural increase?
2. Compare the Malthusian theory with Pearl's theory. What facts do you know that tend to support all or part of each theory?
3. What effects may the emigration of refugees from fascist countries have on the distribution of industries?

[1] Corrado Gini in *Population,* Harris Foundation Lectures, 1929, Chicago, 1930, pp. 112-14

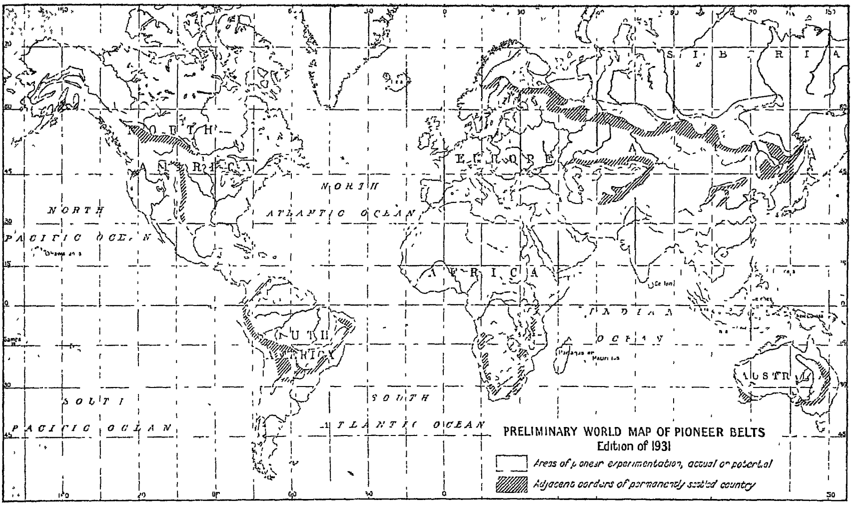


Figure 13. (Reproduced from Isaiah Bowman, *The Pioneer Fringe,* American Geographical Society, N. Y., 1931.)

Some Population Problems

Filling Up the Land. There are still many acres which could be utilized with old techniques or which could be utilized much more fully than they are at present. Many of these lands, such as the more temperate parts of Siberia and favorable parts of tropical South America, suffer from isolation. Until transportation facilities are provided, it will not pay pioneers to settle in these areas. Other areas, such as tropical Australia, could be utilized much more effectively, but laws prohibiting certain kinds of immigration retard settlement. Countries such as Uruguay and Argentina might be more thickly settled by immigration but for the fact that land for small farms is difficult to buy or rent. In such countries, proprietors own the land in large estates which, usually, they will not voluntarily subdivide.

Pioneering in Techniques. Many lands that were at one time considered as waste have recently been utilized by developing new techniques. Dry lands have been made fertile by stream or well irrigation; semiarid lands have been utilized by using dry-farming methods and drought-resistant plants; cool areas have been used for farming by planting rapidly maturing crops. On the map (Fig. 13) are indicated the regions where pioneering is taking place or may take place in the near future.

Declining Old Lands. Pioneering both in space and techniques makes available new resources, but it also creates problems in the old lands. New England farming declined in part because it could not stand the competition of Midwestern farms with more fertile soil Likewise, wheat farming in England has declined because cheaper grain could be shipped from the wheat fields of Canada, the United States, Argentina, and Australia. Later, England suffered from the rise of manufacturing in new regions, which meant reduced markets for English goods. In all of these cases (and many more could be cited), the new lands have discovered some advantage over the old lands—better soil, nearness to the market, cheaper raw materials, newer and improved machinery. The declining regions have fought back with tariff agreements, new techniques, and the development of new industries. For example, New England has given up, in part, some of its former industries and has concentrated on complex manufacturing, commerce and finance, dairy and truck farming, fishing, education, and the tourist industry.

The decline of regions, often accompanied by a decrease in population, changes many of the basic as-

sumptions on which business was formerly conducted. No longer can it be assumed that cities will grow, that land values will increase, and that the local market will continue to expand. Hence cities curb their plans for expanding their utilities, investors avoid real estate as a long-term investment, and merchants aim at efficient operation rather than expansion. It is noteworthy that similar changes in business policy may become necessary if the population of the country as a whole becomes static or decreases.

The Conservation of Resources. Many writers have referred to "the indestructible qualities of the soil," but long experience has shown that there is hardly any aspect of the land resource that may not be harmed by human neglect and carelessness. Mineral resources may become exhausted; forests may be permanently ruined by fire; soil may be leached so as to become infertile, or be washed away altogether. Even scenery may be spoiled by scarring the earth's surface and building ugly houses and billboards. This destruction reduces the carrying power of the land and turns habitable lands into waste regions. China, with its millions of acres of gullied hillsides, its floods and lack of adequate arable land, is an example of failure to solve the conservation problem.

Monopolistic Control of Resources. Inequality is characteristic of the ownership of resources not only in total value, but also in regard to individual articles. The British and the Dutch, for example, control the bulk of the world's tin reserves, and the British and Americans control the bulk of the world's petroleum. So far as arable land is concerned, the Anglo-Saxon nations control a disproportionately large share, while the yellow races must get along with less than an acre per capita (Fig. 14).

Within nations the division of resources among individuals is likewise unequal. In countries where large grants were made in colonial days, or where feudalism was present until recently, a large proportion of the land has been controlled by a small landlord class. In eastern Europe, after the World War, many nations forced the subdivision of large holdings. Other countries have tried heavy taxation on large or unutilized land holdings to force the sale of land.

Interregional Trade and Population. Many regions have a population which far exceeds the *agricultural* carrying power of the land. These localities engage in mining, manufacturing, and commerce. Their food is obtained in exchange for their surplus manufactures, minerals, and commercial services. If interregional and international trade should disappear or decline, the ability of these regions to support a population would decline or possibly disappear altogether. For this reason, the present trend toward economic nationalism is looked upon with fear by such countries as Netherlands, Belgium, and the United Kingdom, which obtain a large part of their food by the sale of goods and services. Economic nationalism tends to reduce the carrying power of the earth as a whole, for it destroys many of the advantages of the geographical division of labor. If each section tries to raise and manufacture all that is consumed locally, many products will be produced within each section under unfavorable natural and human conditions and, therefore, their production will be inefficient. On the other hand, a great increase in world trade might increase the efficiency of the division of labor and thus increase the carrying power of the earth.

Migration and Population. Migration is a possible solution of many of the world's population problems, but any large-scale migration is hindered by countless handicaps. People have many ties to the land they now occupy; they will hesitate to leave their friends and the scenes and systems which they know and understand. Then there is the cost of travel to the new land, the uncertainty as to what they will find there and, finally, the cost and work in building their new homes. All of these considerations as well as legal restrictions hinder migration. On the other hand, there have been a number of cases of large-scale migration. For example, in 1923 more than a million Greeks living in Turkish territory migrated to Greece, where they replaced Turks who emigrated to Turkey. In this way, important and troublesome minorities were eliminated from two countries.

International Danger Spots. Professor Warren Thompson has published an interesting book entitled *Danger Spots in World Population.* His thesis is that difference in population pressure between neighboring nations has been one of the major causes of international conflict. Furthermore, he believes that there are many population danger spots now developing. His facts are most concisely summed up in a table from which Fig. 14 is abstracted.

Considering the European group first, it can be seen that Italy is far inferior to the other great powers in the two most important raw materials, coal and iron; nor is this inferiority compensated by any superiority in agricultural land.

Italy is also inferior in colonial resources to France and Great Britain, who have in the past prevented Italian expansion in North Africa. Furthermore (Fig. 11) Italy has a growing population while her wealthier

Figure 14

RESOURCES OF VARIOUS COUNTRIES COMPARED [1]

		Reserves in tons per capita		Cultivated land in acres per capita	Meadow and pasture in acres per capita
		Coal	Iron ore		
I	Great Britain	4,296	135	.30	.72
I	France	795	200	1.01	.54
I	Germany	3,857	21	.81	.31
I	Italy	6	0 2	.80	.42
II	Japan	126	1 4	.49	..
II	China	1,000	2.6	55	..
II	India	235	10.0	1.16	..
III	Australia	28,000	164	3 92	..
III	New Zealand	2,511	52	1 37	12 35
III	United States	22,796	87	2.85	10.00
III	Canada	71,050	458	6 1	..

neighbor, France, has a static population. From these and other facts, Thompson predicted that Italy would welcome an excuse for a war for expansion. This desire for expansion has been increased by restrictions on Italian immigration into the United States, Canada, and Australia.

In the Asiatic group, all nations are agriculturally overcrowded. Japan, the foremost of the three in industrial progress, is least well supplied with coal, iron, and arable land, while China and India have mineral reserves out of proportion to their present needs. Since India is farther away and is also under the protection of the British Empire, China seems the logical place for political or economic conquest. Japanese officials have used Japan's lack of resources as a reason for economic, and later military, expansion into Manchukuo and China.

By comparing the countries in Groups II and III, it will be noted that Group III is rich in the arable land that the Oriental group lacks Yet every country in Group III has the most stringent immigration laws against Asiatics. Assuming that the Oriental countries continue to increase in population, it may become necessary for them to attempt to take new lands by conquest. On the other hand, the Oriental countries might become more industrialized and sell surplus manufactured goods for surplus agricultural products produced by Group III. This solution is complicated by the fact that three of the latter countries are politically and economically closely connected with industrialized England, while two (the United States and Canada) have highly developed manufacturing industries of their own.

[1] W S Thompson, *Danger Spots in World Population,* p 11. Alfred A Knopf, New York, 1929.

QUESTIONS FOR DISCUSSION

1. Explain each of these statements.
   a. Pioneering today is in technology rather than in space.
   b. Land may decline in carrying power either due to the exhaustion of resources or the competition of other areas
   c. Trade increases the carrying power of the land.
2. Thompson suggests that it might be cheaper in the long run for the British Empire to surrender some of its surplus lands to Japan. Explain. What factors make the adoption of such a suggestion unlikely?
3. Do densely populated areas usually have a low standard of living? Do sparsely populated areas have high standards of living? Explain.

CHAPTER 4

THE TOOLS OF GEOGRAPHY

When Salanio remarked to Antonio in *The Merchant of Venice,*

> ". . . had I such venture forth . . .
> I should be . . .
> Peering in maps for ports and piers and roads,"

he perceived in maps much more than mere patterns of lines and dots. He saw beyond the symbols to the realities which maps represent. Maps provide a convenient summing up of such realities—of physical features, routes, cities, and other data. They generalize and condense in a small space the observations of millions of eyes over millions of square miles during thousands of years. Maps enable these observations to be plotted on a definite scale and are a permanent record which can be used as a starting point by subsequent investigators and which can be corrected and added to as more information becomes available.

Maps, however, are but one of the tools which the geographer uses in handling the unwieldy mass of data within his province. Other tools are graphs, statistics, statistical analyses, gazetteers, and the copious popular and scientific literature which describes the earth and its inhabitants. Without these tools, the student of geography would be unable to know anything definite about an area which he has not personally inspected. Even personal travel, unchecked by the experience of others, may be misleading, for the things seen along the route at a particular time may not be a fair sample of the country as a whole.

Maps and Their Uses

Maps and Geographic Relationships. Maps are the most important of the geographer's tools. By comparing maps of man's economic activities and of the physical environment, those relationships which are the core of economic geography may be discovered. If the areas of heavy rainfall and warm temperature coincide with the areas of rice production, it is a reasonable hypothesis that the two phenomena are connected; but before this coincidence is accepted as a geographic relationship, a careful study must be made to discover just how the relationship works. Sometimes two sets of absolutely independent phenomena almost coincide, although there is not the slightest relationship between them. However, coincidences, as discovered by comparing maps, are important clues and, if a possible cause-and-effect relationship can be suggested, may be accepted as strong evidence of interdependence.

Map Interpretation. Maps may contain much information that is not stated in the legend but can be deduced from past experience in interpreting map data. For example, a series of towns shown on a map at the foot of a mountain range in an arid country may indicate irrigation settlements, mining towns, or both. The names of the towns, such as Leadville, may give a further hint as to the nature of the area. A series of small towns in a line extending at right angles to the mountain wall is probably a string of small irrigation settlements along a stream issuing from the mouth of a mountain canyon. Map interpretation of this sort is not always accurate, but it is suggestive of possibilities which can be checked from other sources.

Each kind of map has its uses and its misuses. Sometimes maps are so constructed that the reader is misled, as may be observed in some advertising and political propaganda. A comparison of the route maps in time tables of two competing railways will often illustrate misleading map distortion. Since maps are both useful and misleading according to their use, the student will find it worth while to develop as soon as possible a good map-using technique. Such a technique can be developed by study, by map use, and, most important, by actual map making. Map making should mean, however, not the mere tracing of existing maps but the construction of new maps, preferably from data collected in the field. Making a map of a small garden, or of the contents of a room, will give the student a good idea of the usefulness of maps in correcting hazy impressions and will make him aware, as well, of the inaccuracies and difficulties

which creep into even the simplest map construction.

Scale. Size and distance are among the most important questions answered by a map. Both of these are represented according to scale. Scale may be defined as *the ratio between a unit of common linear measure applied to a map and the distance which this unit actually represents on the earth.* Thus, at the bottom of many maps, there appears a ratio (expressed as a fraction) such as 1/63,360 (sometimes, 1 63,360). This means that any distance on the map represents 63,360 times that distance on the earth; 63,360 is a convenient denominator because it is the number of inches in a mile (12 x 5280). Thus, when this ratio is used, one inch on the map represents one mile on the earth. To a person using the metric system, it would indicate that one centimeter on the map represented 63,360 centimeters (or .6336 kilometers) on the earth.[1] If the scale of the map were smaller, the denominator of the fraction would be greater than 63,360. For example, if the fractional scale were 1/1,000,000, to obtain the number of miles represented by one inch on the map, divide the denominator by 63,360 $\left(\frac{1,000,000}{63,360} = 15.7\right)$. Then 15.7 miles are represented by each inch on the map.

Conventional Symbols. Many early maps (and some modern maps used in advertising and popular magazines) are easily understood by the uninitiated because they use pictures to supplement the conventional symbols. Cities are represented by a small sketch of some well-known building in each city, products are indicated by a drawing of an ear of corn, a bag of flour, or a lump of coal. Modern map makers have developed a sort of shorthand which, although not so pictorial, does permit the more accurate presentation of more data in a limited space. It is important to learn these symbols if maps are to be used intelligently. On most maps the symbols used are indicated in a legend at the bottom or in one corner of the map, and this legend should be studied before attempting to use the map.

There are three common ways of showing relief: contours, hachures, and physiographic symbols. The last of these methods is illustrated by Fig. 225 (p. 326), and by many of the other regional maps in this book. Essentially it shows relief (and sometimes vegetation) by using conventionalized drawings of mountains, plateaus, and other features. This method produces an artistic and easily understood map; its main disadvantages are that it usually exaggerates the size of relief features and that it gives no exact measure of altitude.

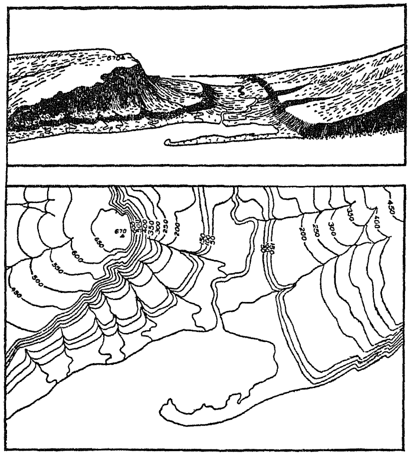


Figure 15 A sketch and a contour map of the same area to show the representation of relief by contour lines. (From U. S. Geological Survey)

Contour maps provide the most exact way of showing relief, especially on large scale maps. A *contour* (or contour line) is a line which passes through all points on the map having the same altitude. Individual contours are referred to by their altitude above mean sea level; thus the 70-foot contour passes through all points that are 70 feet above sea level. It is important to note the *contour interval* which is the difference in altitude between any two successive contours. Small contour intervals, such as 5, 10, 20, and 25 feet are used for areas of small or moderate relief while 50 or 100 feet intervals are used for areas of high relief such as the Rocky Mountains.

After a half-hour of study, the student should have little difficulty in reading the contour maps reproduced in the following chapters. It is helpful to remember that on the steeper slopes the contours are close together and the map appears darker. The slope is always toward the streams and the lighter areas are

[1] 1/63,360 is a common scale in English-speaking countries British topographic maps are on this scale or multiples of it. The topographic maps of the United States Geological Survey are drawn on a scale of 1/62,500 (or multiples of it). This is approximately one inch to one mile. It has the additional advantage of being 16 times the scale 1/1,000,000, which is used on the International Map of the World, a cooperative project sponsored by the leading nations. In countries using the metric system, scales such as 1/10,000, 1/40,000, 1/100,000 (one centimeter equals one kilometer), and 1/200,000 are common.

Figure 16. Contour and hachure maps of a small part of Mount Desert Island, Maine. (After U. S Geological Survey and U S. Coast and Geodetic Survey)

usually in the valleys (except in plateaus where the upland is flat). The common shape of contours crossing a stream is like a U or V with the point of the V always upstream.

Relief is shown on hachure maps by fine lines (hachures) which are usually roughly parallel to each other. They serve as shading and follow the general rule that the closer (and darker in appearance) they are the steeper the slope represented (Fig. 16). Because hachures do not show exact altitudes, a few contours are often included on large-scale hachure maps.

The *layer* map is a simplified contour map with layers of color between the various contours. All areas of from 0 to 500 feet may be colored dark green; from 500 to 1000 feet, light green; from 1000 to 2000 feet yellow; and so on. Layer maps are among the most common and most legible maps used. Various kinds of shading in black and white are often used instead of colors.

Data other than relief may be shown by methods similar to the contour or layer maps. A line connecting all points having equal quantities of an item is known by a variety of names according to the property described. Usually the names contain the Greek root *iso* meaning *equal.* Thus we have *isobar* (line of equal barometric pressure), *isotherm* (line of equal temperature), *isohyet* (line of equal rainfall), and many others. By proper shading or coloring, a rainfall map consisting of isohyets may easily be converted into a layer map.

A recent development is the use of the *dot* map. In this system, each dot represents an indicated amount or number of an item. According to the proportion of the map occupied by the dots, the reader may judge the relative importance of each area in production.

Latitude and Longitude. The relative position of points on the earth's surface is described by latitude and longitude which perform somewhat the same function for places that street names and house numbers perform for city buildings. All map making is based on a conventional system of latitude and longitude.[1] In this system, the globe is quartered by two imaginary great circles which are perpendicular to each other at their points of intersection. Half of one of these great circles is an arc passing from the North Pole through the Royal Observatory at Greenwich (a suburb of London, England) and continuing on to the South Pole. This half circle is known as the Prime Meridian, and places along it are said to have 0° longitude. The other half of this great circle (which passes through the Pacific Ocean) is known as 180° longitude or the 180th meridian. This great circle divides the earth into the Eastern and Western hemispheres. All places to the east of the Prime Meridian are said to be in the Eastern Hemisphere or in east longitude; places west of the Prime Meridian are in the Western Hemisphere or in west longitude.

The second imaginary great circle which is used as a line of reference is the equator, which extends around the earth halfway between the two poles. Latitude is position north or south of the equator. Lines passing through places of equal latitude are called *parallels of latitude* because they are circles parallel to each other. The equator (0° latitude) is the only parallel of latitude which is a great circle; the other parallels become smaller as the poles are approached. The maximum latitude is 90° (either north or south) because there is only one-quarter of a great circle between the equator and the poles.

[1] The student will be able to follow this and Part Two more readily if he has access to a globe. Small but helpful globes can be purchased for as little as twenty cents.

Unlike the parallels of latitude, the lines which connect points of equal longitude are always arcs of great circles. These meridians of longitude come together at both the poles, hence exactly at the pole all longitudes coexist.

Since in latitude and longitude all lines are either circles or arcs of circles, distances are described in degrees, minutes, and seconds rather than in linear measure. There are 360 degrees in a complete circle, thus longitude may run from 0 to 180 degrees east or west of the Prime Meridian. Note that longitude is expressed as east or west of the Prime Meridian, but that the meridians themselves trend north and south. The number of degrees of longitude are obtained by measuring along the equator or any parallel of latitude starting at the intersection of that parallel and the Prime Meridian. The meridians are named by the number of degrees along these parallels between the Prime Meridian and the particular meridian being considered Thus a meridian which is 30° to the west of the Prime Meridian, measured along a parallel, is known as 30° West. The 180th meridian is the same number of degrees from the Prime Meridian whether it is measured from the east or west, hence it is 180° E. or W. or, more commonly, just 180°. Likewise, latitude is determined by measuring degrees along meridians either north or south of the equator. Note that although latitude is expressed as north or south, parallels of latitude trend east and west. A careful study of a globe will clarify these relationships.

At the equator, the length of one degree of latitude or longitude is approximately sixty-nine miles [1] The length of one degree of latitude remains fairly constant, the slight change being due to the flattening of the earth at the poles The linear value of one degree of longitude decreases rapidly as the poles are approached, since the meridians converge at the poles. It is helpful to remember that the length of one degree of longitude at 60° latitude is one-half the length of one degree of longitude at the equator.

[1]

At latitude	*Length of 1° of longitude*	*Length of 1° of latitude*	*Approximate distance around the earth along a parallel*
0° (equator)	69.172 miles	68.704 miles	24,902 miles
20°	65 026 miles	68.786 miles	23,409 miles
40°	53.063 miles	68 993 miles	19,103 miles
60°	34.674 miles	69.230 miles	12,483 miles
89°	1.211 miles	69 407 miles	436 miles
90°	0 miles	69.407 miles	0 miles
Earth's circumference through poles . .			24,860 miles

Describing a Position. The earth is divided into quarters by the Prime Meridian (and its continuation —180°) and the equator. Within each quarter each set of numerical latitudes and longitudes is found. Of course, if it is known that a place is in the United States, it is safe to assume that west longitude and north latitude are meant. However, if the place named is not well known, it is safest to give a full description For example, simply 60° latitude, 40° longitude might be 60° N., 40° W., or 60° S., 40° W.; or 60° N., 40° E.; or 60° S., 40° E.

Greater accuracy may be obtained by giving values in minutes and seconds as well as in degrees. For example, a rectangle one second of longitude by one second of latitude would be, at latitude 40°, about 26 yards from east to west and 33 yards from north to south By using fractions of a second the position of as small an object as a house can be accurately described on the world's surface.

Time

Longitude and Time. A *day* is the time required for one complete rotation of the earth. Each day has been arbitrarily divided into twenty-four hours, and since any one point must pass through 360° in a complete rotation, such a point passes through 15° for every hour of time $\left(\frac{360°}{24} = 15°\right)$. Because the earth rotates from west to east (thus causing the sun to rise in the east and set in the west), places east of Greenwich will have had their noon earlier than Greenwich, thus, when it is noon at Greenwich, their time is in the afternoon Places west of Greenwich will not have arrived at the noon position with regard to the sun, so their time will be in the morning. At 5° E., the time will be 12:20 P.M. (noon plus $\frac{5}{15}$ times 1 hour). At 30° E., the time will be 2.00 P.M. (noon plus $\frac{30}{15}$ times 1 hour). At 75° W. (New York), the time will be 7:00 A.M. (noon minus $\frac{75}{15}$ times 1 hour). Similar determinations of sun time may be made for any number of places on the earth if their longitudes and the time at any one of them are known.

Standard Time. In most countries the difficulties and inconveniences of observing a few minutes' difference in sun time in places close together is so great that, instead of constantly changing the time for every few miles east and west, standard-time belts have been established by agreement and the time

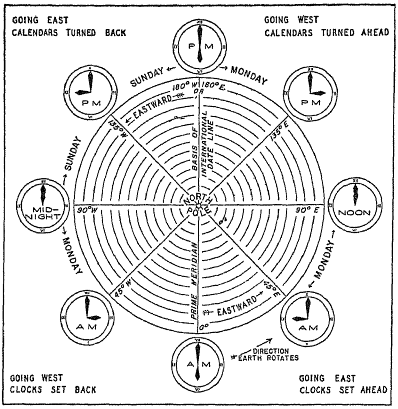


Figure 17. Diagram showing the relationship between time and longitude.

throughout each belt is considered as the same. A change of one hour is made at the crossing of the boundary of each belt. Usually the time in the belt is based on the local time on a centrally located meridian which is a multiple of 15°. The American reader is probably familiar with the belts of Eastern (75° W.), Central (90° W.), Mountain (105° W.), and Pacific (120° W.) Standard Time in the United States.

Difference in time according to longitude causes many apparent anomalies. At the end of the World War, extra papers announcing the armistice were on the streets before dawn in San Francisco, although the event took place at 11 A.M., Greenwich Time, the same day. This was possible because the Greenwich Time used at the Western Front is eight hours ahead of Pacific Time (11 A.M. Greenwich Time is 3 A.M. Pacific Time).

Determining Longitude. Mariners use the time-longitude relationship to determine their longitudinal position. For this purpose most ships carry one or more chronometers which are set to keep Greenwich Time. By observing the position of the sun with relation to the zenith, the local sun time can be determined. Then by comparing this time with the Greenwich Time on the chronometer, the longitude can be determined.

The International Date Line. Another peculiarity of the time situation was brought sharply home to the people of the United States during the winter of 1931-32. At this time the eyes of the world were centered on events in China and Manchuria. News dispatches dated "Shanghai, Dec. 2" were published in American newspapers on Dec. 1. This odd sequence of dates was possible because when it is 8 P.M. Eastern Standard Time, it is 9 A.M. the following morning in Shanghai. This difference in time can be calculated correctly if one adds one hour for each 15° going toward the east. If, however, the time calculation is made toward the west, it will be one day in error unless the date is changed at the International Date Line (Fig. 17).

The sun in its apparent course around the earth carries its daylight with it. Therefore, if man is to use a system of dates which is to apply throughout the world, there must be some place where the day is considered as starting. By international agreement, this place has been located approximately along the 180th meridian, because the difference in dates on both sides of the line will affect fewer people than elsewhere, since the line lies in the Pacific Ocean.

Travelers, when crossing this line from east to west, pass into the next day. Thus, if it is 2 A.M. on Wednesday, June 1, when a Seattle-Yokohama steamer crosses the Date Line, it immediately becomes 2 A.M. on Thursday, June 2, for everyone on board. On the other hand, travelers crossing the line from west to east would go back into the previous day (Thursday 2 A.M. to Wednesday 2 A.M.). To avoid living through most of Wednesday and two hours of Thursday a second time, the added day is called *Meridian Day.*

It is helpful to remember that when the clock is being set forward (that is, sailing east), the calendar is pushed back (one day earlier) when the International Date Line is crossed, and vice versa. Also, any time problem can be solved by working either to the east or to the west. Since the answer will be the same by each method, the solution may be checked by calculating first eastward, and then westward.

QUESTIONS FOR DISCUSSION

1. If you flew directly south from New York to the South Pole, what land masses would you pass over? Is the east coast of South America nearer in longitude to New York or London? Which is it nearer in latitude? What is the commercial significance of these facts?
2. A certain popular radio program is broadcast at 6:45 P.M., Eastern Standard Time. At what times (by local clocks) might this program be picked up by listeners in Chicago? San Francisco? London? Shanghai?
3. A broker in New York receives an order to be executed in the London market It is noon, New York time. Should he send a straight cable or a night letter to his London office?

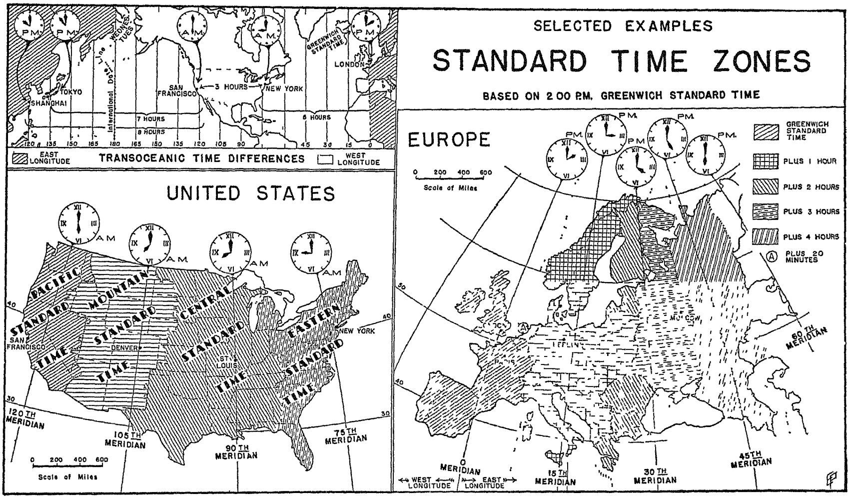


Figure 18. The clocks show the time when it is two o'clock at London.

Map Projections

The simplest type of map is a plan of a small area. On it no account is taken of the fact that the earth is a spheroid and its surface is curved. In maps representing small areas, the error is negligible. In making a map of the whole world, or any large area of its surface, complications arise in attempting to put on a flat surface a representation of what is actually a curved surface. The difficulties of doing this may be realized when one remembers that it is impossible to skin an orange and flatten the skin out into a *continuous whole of any regular shape.* It is even impossible to flatten any considerable piece of the skin out into a flat, continuous, regular surface without stretching or breaking it. Therefore, the only absolutely accurate representation of the world, or any considerable part of it, is a globe or segment of a globe. In spite of their inaccuracies, however, maps are much more practical than globes, for it is hardly possible to reproduce a large-scale globe in a book or a newspaper article.

Maps which are made in a systematic manner are referred to as *projections.* Each part of such a map has a definite relation to the corresponding part of the earth (or a globe) which may be expressed in mathematical terms. Ordinarily, projections are constructed by reproducing the globe's imaginary net work of latitude and longitude on a plane surface.

The Mercator's Projection. One of the most commonly used maps is the Mercator's projection (Fig. 19), which (with some refinements, of interest only to the professional cartographer) is based on the following construction. The globe is assumed to be set in a paper cylinder which is tangent to it at the equator. If the globe is also assumed to be hollow and of glass, a small but powerful light at the center of the globe would project most of the surface features of the globe onto the surface of the cylinder. The regions close to the poles would not be projected, however, because the rays of light transmitted along the earth's axis would continue indefinitely through the bore of the cylinder without touching its surface. For this reason, maps on Mercator's projection seldom show anything above 85° north or south latitude. If the shadows cast on the paper cylinder be traced, the cylinder may then be cut lengthwise and the paper unrolled to form a flat map. Actually, in map making this method of using lights and paper is not employed (mathematical formulas are used instead), but it is described here because it is the easiest way to understand the projection. (See Fig. 20 for illustration of this method.)

The Mercator's projection has the advantage of correctly reproducing spherical angles on a flat surface.

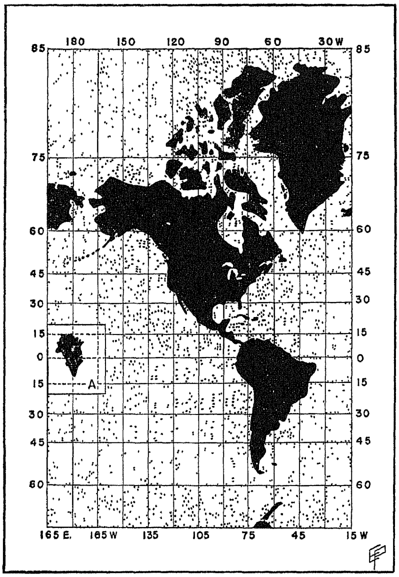


Figure 19. Part of a Mercator's projection of the world. In A, Greenland appears as it would if projected at the equator. Figure 13, page 21, shows a Mercator's projection of both hemispheres.

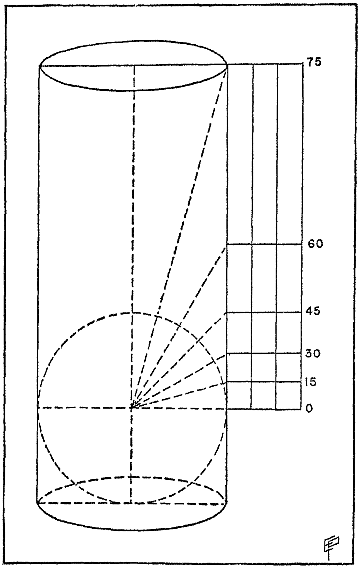


Figure 20. Construction for the Mercator's projection. Usually this construction is modified so as to keep a constant relation between the latitudinal and longitudinal scales.

For example, all parallels of latitude cross all meridians of longitude at right angles both on a globe and on a Mercator's projection. On the other hand, areas are badly distorted, except near the equator; and shapes are also distorted, unless the area mapped is contained within a few degrees of latitude. The nature of this distortion can be understood by imagining an equilateral spherical triangle consisting of the northern half of the Prime Meridian, the northern half of the 90° meridian, and a 90° arc of the equator which connects these meridians. On the globe this appears as a triangle; on the Mercator's projection, as an elongated rectangle with its northern end open.

Such distortion of area and shape is the chief drawback of this projection, and its continued use has fastened inaccurate ideas of relative size and shape of land bodies on numerous generations of students. The distortion is not considerable when applied to Africa and South America, because they lie entirely in the lower latitudes. When these are compared with land bodies in the higher latitudes the relationships are grossly in error. On this projection Greenland appears to be fully as large as South America, whereas it is really only one-ninth as large. (See Fig. 19.) North America appears to be considerably larger than Africa, but is really not quite so large. This sort of error becomes additionally important when one maps the distribution of economic resources in the upper latitudes. The forests of Canada and Siberia seem to be of almost inexhaustible extent, whereas, although considerable, they are really not so great as they appear.

There is, however, one outstanding advantage of the Mercator's projection which has made it of unequaled value for navigation. Mariner's charts are all based on this projection, because on it the navigator can draw a straight line from one port to another and, by measuring the angle of deviation between this line and any parallel or meridian, set his course by a compass bearing which is true for any portion of his course. It is impossible to lay out a straight line course on any but a cylindrical projection.

There are numerous other cylindrical projections

which attempt to do away with some of the disadvantages of the Mercator's projection. Usually these projections, at the same time, lose certain advantages. A common projection is the Stereographic in which the light is imagined as being on the equator directly opposite the point being projected. Using this method, the poles may be projected, and the exaggeration in area is not so great away from the equator. However, the exaggeration is greater from east to west than from north to south, so the shapes are poor and the map cannot be used so easily for laying out a straight-line course.

Conic Projections. Cylindrical projections are usually tangent to the globe at the equator and are consequently excellent for sizes and shapes near the line of tangency (within 20° on either side of the line of tangency the distortion is negligible) The conic projections are equally good for areas north or south of the equator and are the most commonly used maps for areas within the middle latitudes. A paper cone with its apex over the nearest pole is assumed to be tangent to the globe at a parallel of latitude near the center of the area to be mapped, and the surface of the globe is then projected onto the cone from a light imagined as being in the center of the globe. After the projection has been traced, the cone is cut and unrolled into a flat map (Fig. 21).

In Delisle's Modified Conic projection it is assumed that the cone is partially sunken into the globe so that it is tangent at two parallels. In the polyconic, it is assumed that a series of cones, each tangent at a different parallel of latitude, is used In this case the latitude lines come out on the map as arcs of circles with differing radii. The east and west directions thus bear a different relationship to the right- and left-hand sides of the map in different latitudes. Even in the simple conic projection the parallels are arcs of circles on the map, and therefore the east-west direction is along the parallels, whatever their direction, rather than straight toward one side or the other.

The conic projections are not exactly equal area, but they do give good shapes for countries in the temperate zone and are satisfactory for most purposes, if the area is not too large.

Equal Area Projections. It is impossible to construct a flat map of the world which will be accurate both in shapes and areas. In equal-area projections, shapes (and usually distances) are distorted in order to preserve accuracy of area.

The best known of the equal-area projections is Mollweide's. To construct a grid for this projection,

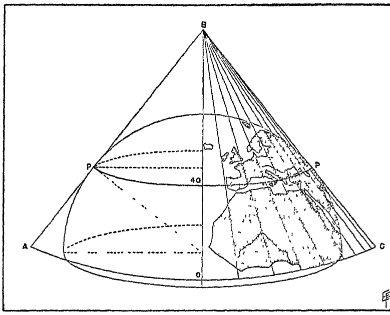


Figure 21 Diagram to show the construction of a simple conic projection Figure 18 (United States) is drawn on a conic projection.

a circle is drawn which represents the area of one-half of the earth's surface. Ellipses are drawn within and surrounding this principal circle to represent the meridians of longitude. Each ellipse is so constructed that the area included within it has the same ratio to the area in the circle that the area included within those meridians on the earth's surface has to one-half of the earth's surface. Parallels of latitude are drawn parallel to the equator at such distances that the area between each pair of parallels is proportionate to the equivalent area on the earth's surface. The resulting grid, on which the earth's features are drawn, is an ellipse (Fig 22).

Interrupted Homolographic Projections. The distortion of the continents distant from the central meridian on Mollweide's projection led Dr. J. Paul Goode to develop the interrupted homolographic projection, which reduced the distortion of shapes in the centers of the continents. By refining this so that sinusoids rather than ellipses are the meridians in the lower latitudes, he has developed what he calls "Goode's Homolosine projection." This probably comes nearer than any other projection to representing on a flat surface the truth about distributions on the globe. It has therefore been used for a large proportion of the world maps in this book (for example, the occupations map, pages 14-15).

By imagining an orange peeled in gores and the whole left hanging together at the equator, the student can see the principle employed. Each continental mass serves as the center of a gore and each, thus, has a true shape. The interruptions between the gores in most of such maps come in the oceans where they do less violence. The map is truly an equal-area one; all

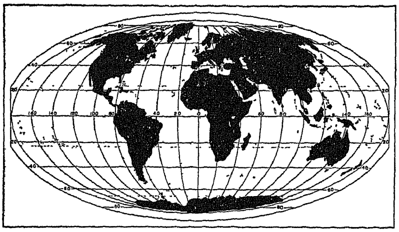


Figure 22. Mollweide's homolographic (equal area) projection.

land masses may be made relatively true in shape, and their latitude relations are true. Longitude relations are true within each gore and, as these include all the land, the main presentations of distance and direction, as well as area, are actual. If it is desired to show the oceans as complete units, this projection may be constructed with the interruptions in the continents.

There are numerous other projections, most of which are modifications of those described above or are combinations of two or more of them. For example, the Van der Grinten projection is a compromise between the Mercator's and Mollweide's projections; it averages both their advantages and disadvantages.

Directions on Maps. Most people have probably learned that north is toward the top of the map and south is toward the bottom. Actually, north is toward the North Pole and south toward the South Pole. The meridian passing through any point under discussion connects the North and South poles and thus trends toward the north and south. If the map projection is a cylindrical one, such as Mercator's, the top of the map is, then, from every point, the north and the bottom the south. In almost any other projection the meridians tend to converge on a single point, as they do on the globe. In this case direction north or south is along the meridians, regardless of whether this is straight toward the top or bottom of the page or not.

In a like manner, east and west directions are always along parallels of latitude. In most projections, lines of latitude meet the sides of the map at right angles, and east is thus directly toward the right at any point and west is toward the left. In the conic projections, as mentioned above, the parallels of latitude do not meet the edge of the map at right angles, and east-west directions are along the parallel and not only do not lie immediately to the right or left from any point, but may vary both with latitude and longitude.

The Globe the Only True Map. As has appeared from the discussions above, there is no absolutely accurate map of the earth's surface or any part of it except a globe. For most practical purposes, however, a flat map made on a satisfactory projection is accurate enough. A globe should, however, be used whenever one is available. Only on a globe are the true relations of places to each other to be seen accurately. Only a globe will demonstrate convincingly the shorter distance between high-latitude points by way of the poles and the value of polar routes of travel if they can be made safe. Only on a globe can the true relationship of the English Channel area to the rest of the world—a relationship which probably goes far to account for the leadership of this area in world affairs—be shown There are numerous other relationships of great economic significance which a globe alone will demonstrate.

QUESTIONS FOR DISCUSSION

1. Which projection is best for
   a. a world map for comparing areas under wheat cultivation?
   b. a world map showing accurate wind directions?
   c. a map of the state of Colorado?
   d. a map showing the areas within 10° of the equator?
   e. a map showing the area and shapes of the New England states?
2. What are the advantages and disadvantages of each of the projections described?
3. How may each of the principal map projections be identified if not labeled?
4. Examine the maps in Part Five of this book. Identify the projection of each.

Other Geographic Tools

Gazetteers. A gazetteer is a dictionary of geographical names. Assume that a student hears a radio announcer refer, in passing, to "Palmella." From the context it may be impossible to tell in what country it is, or whether it is a city, lake, or mountain range. If the student turns, for example, to *Lippincott's New Pronouncing Gazetteer of the World,* he will find "Palmella" described as follows (1922 edition):

PALMELLA, pal-mel'la, a town of Portugal in Estremadura, 18 miles SE of Lisbon. Its mediaeval walls still survive. Pop. (commune) about 7000.

It will be seen from the example given that there will be no difficulty in locating the town. It is in the province of Estremadura and eighteen miles southeast of the capital of the country—Lisbon—which will

be on every map of Portugal. Its population and any points of note are also given.

Many of the larger standard atlases have abbreviated gazetteers as a sort of index in the back. These usually give merely the latitude and longitude of the place and the country. Some indicate the page on which the proper map may be found. Other atlases have indexes which locate places as follows "Philadelphia—P. 84—G. 7." This means that the map showing this city is on page, or plate, 84. The map will have a series of letters along its top and bottom margins and a series of numbers along the side margins. In the neighborhood of the crossing of the line connecting the G's with the line connecting the 7's will be found the required city.

For the more important geographical names, the large encyclopedias also serve as gazetteers. They do not, of course, list so many names, but for the more important ones they do give a great deal more information. Dictionaries also contain much information about the more important names.

Variants of Place Names. American travelers in continental Europe are often surprised to find that the names of the railway stations differ from those in the English atlases. This is because our forefathers have translated or altered many of the foreign names to make English equivalents. The same thing has been done in other languages, so there are often as many variants of place names as there are languages. For example, the place commonly known as Warsaw, Poland, is known in Polish as Warszawa, Polska, in German as Warschau, Polen, and in French as Varsovie, Pologne. This, of course, causes considerable confusion in reading time tables and in the international postal service. A good rule for travelers is to learn the names commonly used in the country they are visiting.[1]

Recently, the United States Geographic Board has ruled that the form used by the natives of each country for places within their country shall be adopted as correct in the United States. The names of countries are excepted; also the names of features (such as mountains and rivers) which extend through more than one country. Hence, the preferred form[1] in American atlases and textbooks hereafter is the native form; and, hereafter, Rome, Vienna, Venice, and Moscow are to be spelled and pronounced Roma, Wien, Venezia, and Moskva. For many years, both the old and the new forms will probably be in common use, but as better transportation and communication break down distance barriers it will become increasingly important to know the native forms. It is not so hard to learn the new forms as one might think, because they usually resemble the anglicized forms.

The Uses of Statistics. In geography, as in all sciences, data should be expressed quantitatively wherever possible. Failure to do this may result in very misleading ideas. For example, consider these nonquantitative statements: "Bananas are grown in New York City"; "Bananas are grown in Jamaica, British West Indies." Both statements are true, but the bananas in New York City are limited to a few bunches grown in botanical-garden hothouses. Jamaica, on the other hand, produces about 25,000,000 bunches annually and is among the world's leading producers. Correct statistical methods can do much to eliminate distorted ideas. Statistics give proportion to ideas of quantity just as maps clarify ideas of position in space.

Statistics also make possible the discovery of explanations, trends, and principles which would not otherwise be apparent. Suppose, for instance, that there are two corn-growing areas. Both are described as having "adequate rainfall and loamy soil." Thus far the areas seem identical, but production statistics raise a question, for Area A raises 50 per cent more corn per acre than Area B. Until the environment is examined on a quantitative basis, it may be difficult to find any environmental explanation of the difference in production. By introducing more statistics, it might be discovered that the loamy soil in Area A contains 15 per cent more plant nutrients than the loamy soil in B, and that the moderate rainfall in A is five inches more per year and better distributed than in B. These statistics provide a strong clue to the probable explanation of the 50 per cent difference in yield per acre. Suppose, however, that there were no appreciable quantitative differences between the environments in Area A and Area B; then it would be necessary to examine the skill and energy of Farmers A and B to find an explanation. In many cases, both human and environmental differences enter into the complete explanation. Pages 9-10 (in the discussion of Huntington's theory) contain another example of the use of statistics in discovering geographical principles.

Many statistics are needed daily in business and research which, if not known, must be found rapidly.

[1] The authors favor the use of the native forms, and advise that all students and teachers learn them Nevertheless, they recognize that for the next few years most teachers and students will have learned the anglicized names in their elementary school work. Consequently, to suit their convenience and, at the same time, help them learn the native names, this text will use the anglicized form followed by the native form in parentheses.

It is of utmost importance to know where to find these statistics quickly. A few hours spent in becoming acquainted with statistical sources will save weeks later in scholastic and business work. While becoming acquainted with various statistical sources, it is well to examine the relative reliability of each. Some sources (often called *primary* sources) are based on original tabulations or experiments, but others, less reliable, are more or less accurate copies of other sources. Each time the statistics are copied there is a chance for error; hence a third-hand source is less likely to be accurate than a second-hand source, a second-hand source is usually less accurate than a primary source.

A list of the most convenient sources of geographical statistics will be found in the Appendix.

The Literature of Geography. The geographer's laboratory is the world. Since it is hardly possible for any geographer to be personally acquainted with all of the world, he must obtain much of his data from literature, maps, and statistics. Of these three sources, literature is perhaps the most difficult to use wisely. The geographer's library includes a wide variety of works, drawn from almost every field of science and art. In quantity, the available literature consists of hundreds of thousands of volumes in every written language. To choose from this mass of print what is needed to solve a particular geographic problem is no easy task. The bibliography in the Appendix lists some of the sources which are most generally useful.

An important step in selecting a working bibliography is to determine the reliability of the various works on the subject at hand. The reputation and experience of the author should be learned, if possible, before placing overmuch dependence on his statements. Often the preface or introduction will give some hint as to the reliability of the book. Likewise, the style of writing may provide a clue. A hastily written book in journalistic style is often not dependable. Frequently its facts and opinions are obtained second- and third hand from an uneven collection of sources. On the other hand, a carefully documented study by a man of long experience in the field is of the utmost value. In between these extremes are a variety of works: memoirs, travel books, critical analyses, textbooks, and others. Each of these must be judged on its merits. Often an otherwise valueless book may contain some excellent anecdotes or descriptions based on the author's personal experience. Likewise, presumably careful studies may contain unreliable material, especially when the author has some prejudice he wishes to propagate.

QUESTIONS FOR DISCUSSION

1. What information would you include in a gazetteer if you were writing a description of your home town?
2. What scales would be appropriate for a map of your school in a book 7 by 9 inches? of your state? of the world? (Express fractionally and as miles to an inch.)
3. How would a contour map of a conical hill, 100 feet in height, appear if you used 10-foot contours? Suppose you used 20-foot contours. How would it change the appearance of the map? Which map would be more accurate?
4. The following place names are spelled correctly according to the United States Geographic Board. How many can you identify and locate?

Wien	Istanbul
Köln	Athenai
Baile Atha Cliath	Genève
Habana	Anvers
Peiping	Napoli

REVIEW QUESTIONS ON PART ONE

1. Explain and illustrate each of the following terms:

economic geography	climatic energy
site, position	Malthusian theory
realized environment	Pearl's theory
physical environment	pioneering
standard of living	International Date Line
cultural diffusion	Mercator's projection
race	conic projection
selective migration	Mollweide's projection
latitude, longitude	homolosine projection
destructive exploitation	productive exploitation

2. What does each of these facts tell about the location of a place:
   a. It is 7 A.M. there when it is noon at London.
   b. It is within Huntington's region of very high climatic energy.
   What city fulfills all of these requirements?
3. In determining the density of population, the carrying power of the land is less important than the occupations followed. Is this statement true? Explain.

Part Two: THE PHYSICAL ENVIRONMENT

CHAPTER 5

THE EARTH'S CRUST

GRAVITY and the need for oxygen force man to live in that narrow zone where the earth and its atmosphere meet. But the earth's surface on which man lives is not merely a place upon which to place his feet or lay down his body. In addition, from its soil he receives his food and much of his clothing and shelter; and from its nearer depths he derives his building stones, his fencing materials, his metals, and many of his sources of power and fuel. In describing man's earthly environment, therefore, it is necessary not only to describe the unevenness of the surface over which he may toil with greater or less ease, but also to analyze the *nature* of the surface as to its soil and the nature of the zone beneath the surface from which he draws so many useful minerals. This is the true "crust of the earth" as it immediately affects man.

The Continents and the Oceans. Since man is fundamentally a land animal, the fact that but one-fourth of the earth's area is dry land is of primary importance. The continents are but high plateaus of irregular surface on the face of the earth, and most of the isolated islands are merely peaks of mountains in the sea that are so high that they are not covered by water. It is common for man to think of the surface of the earth as being irregular only on the continents. Actually, there are great and significant differences of depth in the sea, although the most vital irregularities are those which divide the earth into land and sea.

A second major geographic fact is the uneven distribution of land masses over the face of the earth The bulk of the land is grouped around the North Pole, and much more is concentrated in the Eastern Hemisphere than in the Western Hemisphere. Indeed, the concentration of land is so conspicuous that it is possible to divide the earth into a "Water Hemisphere" and a "Land Hemisphere," as shown in Fig. 23

Although the dividing line between land and sea is apparently sharp, the ocean basins do not begin abruptly at the shore. There are areas, often of considerable extent, which are but slightly below the level of the sea. Usually these bordering areas slope gently away from the shore of the land for some distance and then reach a zone where the descent to the real depths of the ocean basin begins. This zone is usually considered the true line of demarcation between the continent and the ocean basin. The submerged area between it and the land is called the *continental shelf*. This shelf is of considerable significance to man, since it usually includes the more important fishing grounds and has certain effects on tides and the roughness of the seas. The great continental shelf of western Europe is especially important, since it reaches far to the westward from the main shore line of the continent and includes the British Isles and their associated fisheries. The continental shelf on the eastern coast of North America includes the important fishing grounds off New England and the Grand Banks off Newfoundland. There are other important continental shelves off the east coasts of Asia and South America. On the west coasts of the two American continents and the west coast of Africa, the bottom slopes rapidly away from the land and the continental shelf is very narrow.

The Significance of the Forms of the Land's Surface. Man is most immediately influenced by the lesser irregularities which occur on the land which is his permanent home. The force of gravity gives these land forms great significance. It is gravity that causes the rain water to run down the steep slopes and sweep away the soil, thus confining most of man's agricultural activities to the more level land. It is gravity, again, which makes mountains a barrier, because, in transporting himself or his goods over them, he does so against gravitational attraction. The difficulties of transport caused by the inequalities of the earth's surface give land forms their greatest meaning to man.

Height alone, however, is insufficient to explain fully the barrier effect of irregularities in surface. The

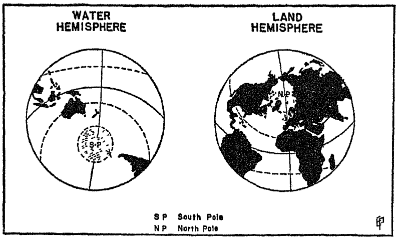


Figure 23 Note the central position of northwestern Europe in the land hemisphere. Both the British Isles and New Zealand are near the centers of hemispheres on these maps. How have their positions influenced their development?

degree of difficulty of passage is also of importance. A high mountain range may have many low passes which decrease its barrier effect. A plateau may be as easy to get around on, locally, as a plain. On the other hand a steep-sided gorge a few hundred feet deep and just too wide to bridge may be as great a barrier as a mountain range thousands of feet high.

Topography and Relief. There are two terms which are used commonly in geography to describe the surface of the land. The first is *topography* which is technically *a description of the surface features of a region.* It is also used synonymously with the features themselves; for example, a region may be said to have *flat, rough, hilly, or rugged* topography. The word also has an adjective form, as in the expression "topographic map." [1]

The second term is *relief* which is *the unevenness of the land surface,* or the difference between the elevation of the highest point and the lowest point in the area considered. Because relief by its definition assumes unevenness, adjectives of degree are often used with the noun—such as *high* or *extreme* relief and *low* relief.[2]

[1] It should be noted here that English writers use the term "topography" somewhat differently With them it includes not only the surface features, such as hills, plains, streams, etc., but also what is known to American geographers as "the culture," *i.e.,* the roads, buildings, and other things that man has placed on the surface.

[2] "Physiography" is another term that is often used in connection with the study of the earth's surface. It may be defined as "the science which treats of the earth's exterior physical features, climate, life, etc, and of the physical movements or changes of the earth's surface, as the currents of the atmosphere and ocean, the secular variations in heat, moisture, magnetism, etc." (Webster's Revised Unabridged Dictionary). As can be seen, physiography is a study, not only of land surface and how it comes about, but also of climate and other physical phenomena. It is synonymous with "physical geography" and should not be used as applying *only* to surface features and should never be used as a noun synonymous with "surface."

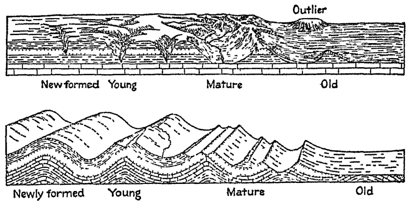


Figure 24. The topographic cycle in horizontal rocks (above) and in folded rocks (below) (Courtesy of the Pennsylvania Geological Survey)

How Land Forms Come About

The Age Cycle in Topography. The relief of the land at any moment represents but a stage in the continuous battle between those forces which are tending to increase the irregularities in the land and those which are continually working to reduce it all to one level plain. The constructive forces—such as volcanic activity and the folding and faulting of the earth's surface—tend to raise up some portions of the earth and depress others. Upon the irregularities thus created, the destructive forces—the weather, ground water, streams, waves, and ice sheets—work to break down the irregularities by moving away the loose material to lower ground and, perhaps eventually, to the sea.[3]

The scenery at any one time depends on which group of forces has predominated recently. If the forces which raise up have been active recently, as measured in terms of the age of the earth, the surface features will tend to be sharp in their irregularities. The same will be true, even though the destructive forces have been active less recently, if the area is one of little rainfall so there has been little effect of running water. Such topography is said to be *youthful.* If, however, the last crustal movement or volcanic activity occurred long before; and if the rains, snows, thaws, and freezes of millions of years have worked upon the surface, the slopes will be gentle and rounded, the mountains worn down to hills, and the valleys will be broad and shallow. Such topography is said to be *mature* or, if the irregularities have almost disappeared, *old.*

The Constructive Forces—*Volcanism.* Volcanic action, because it produces great cone-shaped peaks such as Fujiyama or Vesuvius, is the most apparent

[3] The destructive forces sometimes temporarily increase the irregularities, as when streams cut canyons in a plateau, but on the whole their work is tearing down and leveling.

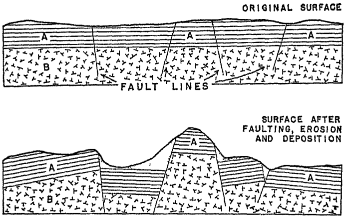


Figure 25. Diagram to illustrate faulting and results of subsequent erosion.

and striking of the agencies which give rise to mountains. *Volcanism*—the name given to the general force which brings molten masses of rock material from great depths up to, or near, the surface of the earth—has, however, other effects which are less spectacular, but equally important in their influence on land forms. For example, under some conditions, lava flows from surface fissures in great sheets over the surrounding countryside. In other instances, volcanic material may be forced between layers of rock beneath the surface, resulting in the raising up of the surface rocks.

Diastrophism. Crustal movement, or *diastrophism,* is another great force giving rise to major surface irregularities. The earth's crust is not a compact, continuous whole, but a series of great blocks, irregular in size and shape, which are separated by lines or zones of weakness called *fault lines* (Fig. 25). Due to forces within the earth and erosion on its surface, these blocks change their relations to each other from time to time and assume new equilibriums. Sometimes the main change of relationship is vertical—that is, one block is raised or lowered in relation to its neighbors. This change is constantly going on, usually so gradually that it is not noticeable except over very long periods.

When these readjustments of level are sudden and considerable, they cause earthquakes, which are often destructive of life and property. The principal earthquake zones of the world are located in regions where there is an almost continuous slipping along major fault lines. These areas of unstable equilibrium (*seismic belts*) have long been known and mapped (Fig 26). Although destruction of life and property has often been tremendous, it has been reduced somewhat in recent years by the development of so-called "earthquake-proof construction," at least in regions that have high enough standards of living to afford

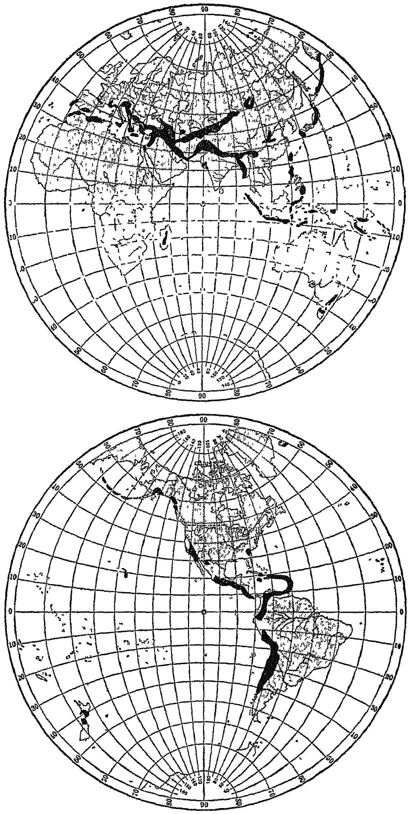


Figure 26 Seismic Belts of the World. (Reprinted by permission from *Textbook of Geology, Part I,* by Pirsson and Schuchert, published by John Wiley and Sons, Inc.)

such construction. The principal damage in an earthquake results from the horizontal movements set up in the earth's surface by the jar which occurs when blocks slip along the fault line. Most types of buildings are not constructed to stand these sudden horizontal strains. The substitution of steel and concrete construction for brick and wood adds tremendously to earthquake resistance. In densely populated parts of the world within the earthquake zones—such as Japan—conflagrations, started when flimsy wooden

houses are shaken down upon the domestic fires, often cause more loss than the actual wreckage of the buildings. It is this secondary damage which has caused the people of San Francisco to speak of "the fire," rather than of "the earthquake," of 1906.

Advances in the science of *seismology* (the study of earthquakes) have made possible a cautious beginning in insurance against earthquake damage. Thus, while man cannot prevent earthquakes, he is beginning to make financial as well as constructional adjustments to them which will decrease the harm they do. It should be noted, however, that *this is possible only at a cost.*

Coastal Emergence and Submergence. Another important aspect of crustal movement is the general raising and lowering of whole continents and parts of continents so as to affect their relation to the sea level. If a whole section of a continent is raised above its former level, the former continental shelf becomes a coastal plain of low relief, usually sloping very gently from the edge of the former coast line to the present shore. This is called an *emerged coast.* Across this the rivers must extend their courses to reach the sea and, because the grade is not great, they are usually sluggish, shallow streams with winding courses. The general outline of such a coast is regular.

If, on the other hand, a great section of the land is depressed below its former level, the sea floods the lowlands and creeps up the valleys, leaving only the highlands and mountains above the level of the water. The coasts of Norway and British Columbia are examples of a *submerged* or *sunken* coast. They are characterized by many islands, representing the tops of the old hills, and by deep and narrow indentations and bays which mark the old river valleys and lowlands between the hills (Plates II E and V D).

A submerged coast is usually one which makes for a greater number of good harbors because it affords sheltered inlets and the water is apt to be deeper close to shore. The emerged coast, because of its more even coast line and shallower water, is usually less well supplied with good harbors. The east coast of the United States south of Cape Cod is largely the result of the elevation of the continental shelf until part of it has become the land of the Atlantic Coastal Plain. Here, fortunately, there has subsequently been a slight sinking of the coast, allowing the sea to come up the river valleys as in the mouth of the Hudson, forming New York Bay, and the mouths of the various rivers whose lower valleys now form Chesapeake Bay.

Folding and Warping of the Earth's Crust. In addition to the important land forms affected by the vertical shifting of the blocks of the earth's crust, there are those which result from the horizontal pres-

ANALYSIS OF PLATE I: TWO CONTRASTING LANDSCAPES

I A (frontispiece). This mountain scene is on the northern boundary of the Alps where they join the Bavarian Plateau (in left background) The mountain topography is intermediate between youthful and mature conditions. The valleys are U-shaped as a result of glaciation; hence the streams are able to meander more than would ordinarily be possible in such young topography.

I B. Here the head of Newark Bay has been filled with alluvium by the Passaic and Hackensack rivers. The land is nowhere more than a few feet above high tide and is consequently swampy. Poor drainage and the mosquito menace have prevented much residential development, although the population is dense on the higher ground of the Palisades (an igneous intrusion), which appears in the background, and on Manhattan Island, which appears faintly in the distance The swampy area is suited, however, to some types of industrial plants, such as the power plants, gas works, and chemical plants visible along the river banks These industries require cheap fuel (brought in by water) and nearness to urban centers. The elevated highway was constructed to avoid opening the drawbridges over the rivers and to eliminate grade-crossings on what is probably the most intensively-used automobile route in the world.

ANALYSIS OF PLATE II: TYPES OF LAND FORMS

II A. Sharp outlines and steep slopes characterize young mountains. Accumulations of snow in high valleys, such as that in the upper right background, are common sources of mountain glaciers.

II B. Rounded outlines and gentler slopes are typical of the more mature mountains. Between such mountains occur broad valleys filled with cultivated fields and prosperous farm villages.

II C. The New River has cut a narrow, steep-sided valley into the Appalachian Plateau. The even skyline marks the original surface of the plateau. The Washington-Cincinnati line of the Chesapeake and Ohio Railroad follows the narrow valley bottom because it offers the only uninterrupted route with gentle grades through this region. Plate IV C shows part of the same valley further downstream where the topography is maturely dissected

II D. In this mature valley, the valley bottom is not much below the upland level and the descent to the bottom is gradual. The bottom lands, enriched by alluvial deposits, are well cultivated.

II E. Deep arms of the sea penetrating far into the land are typical of fiorded and other submerged coasts. Before submergence, these fiords were U-shaped glacial valleys.

II F. An example of newly-formed land.

sures which cause folding and warping. Mountainous regions formed in this way usually occur as belts of roughly parallel ridges, as in the Ridge and Valley region of the Appalachians (Fig. 227) The results of such folding are usually complex, especially after the destructive forces have been at work for some time. It must be remembered that this folding takes place gradually over many thousands of years. Often the bending of the strata is intermittent and long periods of erosion may occur between successive warpings and thus complicate the relief. The simplified diagrams of Fig. 27 illustrate this process much better than any description can.

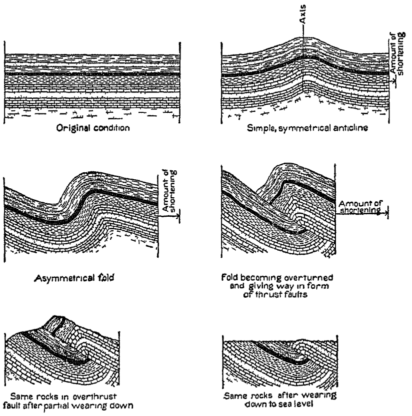


Figure 27 An example of folding which results in faulting. Note how erosion finally destroys most of the surface evidence of the crustal movement (Courtesy of the Pennsylvania Geological Survey)

QUESTIONS FOR DISCUSSION

1. Examine Fig. 23. Why was the North Pole reached before the South Pole? Why have air routes over the Arctic Ocean been arousing interest in recent years?
2. Are earthquake zones correlated with volcanic activities and high mountains? Why?
3. What are the advantages of a submerged coast? What disadvantages might it have? How would a submerged coast which had afterwards partly emerged appear on a map?

ANALYSIS OF PLATES III AND IV: TOPOGRAPHIC MAPS

These maps are reproduced from the U S. Geological Survey quadrangles named in parentheses below.

III A. (Mt. Whitney, Calif.) The left half of the map represents the crest and steep eastern slope of the great Sierra Nevada block. The county boundary (marked by heavy, broken black lines) runs along the crest. The western third of the area has been glaciated. A typical landscape in this area is shown in Plate II A. The right half of the map represents a barren region in the rain shadow of the Sierra. Note the intermittent lakes and streams The heavy blue line near the right edge of the map is part of the aqueduct which carries Sierra water over 200 miles to Los Angeles. Note also the earthquake fault which is evidence of recent diastrophism in this area.

III B (Raleigh, W. Va.) Part of this area is shown in Plate II C Most streams are fairly young near their headwaters and become more mature as they flow toward their mouths. Compare with Plate IV B.

III C. (Saybrook, Conn) Compare with Plates II D and IV B.

III D (Sheet 2307, Port Valdez, Alaska) What is Shoup Bay? What caused the marshy areas in and at the mouth of Shoup Bay? Is there any evidence that this glacier was once deeper than at present? What is the slope per mile on the trail from Shoup Bay to Midway Camp? Why are there any trails or camps in such a cold area? Note the brownish shading on Shoup Glacier. This is morainal material which has been deposited by tributary glaciers or which has fallen onto the glacier from the valley sides

IV A (Millersburg, Pa) This map represents most of the area shown in Plate V A.

IV B (Charleston, W. Va.) The many streams, the flood plains in the main streams, and the lack of undissected uplands are characteristic of a mature plateau. Coal mining is the main reason for the many roads and houses here.

IV C (Ely, Minn) The continental glacier smoothed off this area and then deposited a ground moraine which, by blocking the streams, formed numerous lakes and swamps. As much as possible the roads and trails are constructed on the morainal hills. The area is valueless except for lumbering, hunting, fishing, and camping. The presence of rich iron deposits to the east has helped the development of the area.

ANALYSIS OF PLATE V: MAN AND LAND FORMS

V A. The Susquehanna River has cut a gap across a ridge of hard rock while the adjacent softer rocks have been eroded away Note that the transportation routes are concentrated on this gap. Millersburg (at the left) owes its growth to a position where traffic along the valley to the left joins the main lines of traffic following the Susquehanna between the interior and the cities of the East. The broad valleys on each side of the ridge are mature in their topography.

V B Silverton is not located near any main route and its site would probably not have been used were it not for the precious metals in the surrounding complex volcanic San Juan Mountains The shafts of several mines can be seen at the edge of the mountains. This photograph was taken from a mountain overlooking Silverton. The site of the town is a glacial trough which has been partly filled with alluvial deposits by the stream in the center of the picture.

The Destructive Forces

Weathering. This force operates mainly through the effects of changes in temperature and is, therefore, most active in regions subject to considerable variations in temperature from day to night or from season to season. As the surface of a rock is heated by the sun, it expands. Because this heat does not penetrate very far into the rock, the surface tends to crack away from the center and flake off. Conversely, rapid cooling at the surface of the rock causes the surface layers to contract faster than the interior, also resulting in cracking and flaking off.

Another way in which heat and cold tend to break down rock is through the "wedgework of ice." Most rock is cracked and seamed and ground water settles in the cracks. During cold weather, this water freezes and expands,[1] prying the portions of the rock apart. As the ice melts, the water takes up less space, and the alternate contraction and expansion of the water does much to split up the rock beneath the surface.

The air, itself, as it comes in contact with rock, acts as an agent of weathering. Iron in rock oxidizes in contact with the oxygen in the air; carbonization results from the contact of the atmospheric carbon dioxide with many chemicals in the rock. These processes, by changing the nature of the materials in the rock, lead to its decomposition.

Ground Water. In a like manner, the chemicals found in the ground water alter rock chemicals and structure. They attack the cementing materials which bind the particles together and, when these materials are carried away in solution, they leave the particles subject to easy movement by the transporting agencies. In limestone, which is made up largely of calcium carbonate, water containing carbonic acid rapidly transforms the calcium carbonate to calcium bicarbonate and may completely break down large quantities of rock in a relatively short time. This action causes extensive caverns in limestone areas. Where the roofs of these caverns collapse, "sink holes" develop and do much to create the rolling topography characteristic of such limestone areas as the Shenandoah Valley in Virginia or the Blue Grass Region of Kentucky.

Plants, Animals, and Man. As the roots of plants grow into cracks in the rocks, they act as wedges and tend to pry the rocks apart. Plants, in their growth and decay, also add to and subtract from the chemicals in the air, rocks, and water and further contribute to the chemical forces attacking the bedrock. Animals, burrowing in the ground, open up new channels for the circulation of air and water and bring half-decomposed rock materials to the surface where they weather rapidly.

Man has become an increasingly important agent in the process of rock disintegration. His mining, quarrying, and road-building operations have exposed new rock surfaces and his cultivation of the soil has caused important changes in the circulation of air and water. His removal of plants, such as forest or grass, has often led to the rapid washing away of the covering material and the exposure of the rock surface over large areas.

Running Water. By far the most important of the destructive forces is running water. As the rain falls upon the land, some of it sinks into the ground and becomes ground water. The remaining part that is not immediately taken up by plants, or evaporated, or caught in swamps and ponds, immediately runs off over the surface toward lower ground. As it journeys toward the sea, it *erodes,* that is, wears away, the earth's surface. There are three parts to this process of erosion, namely, *transportation, solution,* and *corrasion.*

Transportation. The mud, sand, and pebbles seen moving in almost any stream furnish common evidence of the transporting power of running water. The power of the stream to carry this material varies as the sixth power of its velocity. Thus if the velocity of a stream is doubled, its transporting power is sixty-four times as great as before—hence the destructive power of rivers in flood. Swift streams can carry large boulders, but sluggish streams carry only the finest of silt. If a stream is slowed down by a change in its volume or gradient, or by junction with an opposing current, its transporting power declines rapidly and it may deposit huge quantities of material in bars and deltas.

Solution. Streams dissolve rock materials in the same way as ground water, but, since they flow more rapidly, solution tends to occur at a faster rate.

Corrasion. The particles of silt, sand, or gravel in swiftly flowing water act as a sort of liquid sandpaper. The sides and bottoms of streams are cut away by this abrasive force, which is especially great during flood stages when larger particles are carried.

The Destructive Work of Ice. The destructive work of moving sheets of ice is confined at present largely to the very high mountains with their associated valleys and to the polar regions. In these areas,

[1] While most substances *contract* as they cool, water *expands* when freezing.

snow accumulates from year to year because the short summer seasons are not long enough or warm enough to melt completely the year's fall. Under the force of its own weight, the snow underneath is compacted, becomes granular, and is finally formed into dense ice. As its thickness increases, the ice tends to move outward from the point of greatest thickness on level areas, or to move down slopes on mountains. Such moving sheets of ice are called *glaciers.* This ice, like water, does most of its wearing work by means of the tools which it carries. As the ice forms, it freezes to the surface materials. When it begins to move, it plucks out or breaks off pieces of rock and quantities of gravel. All these grind and polish the sides and bottom of the valley as the glacier proceeds and do much of the destructive work. The rate of movement of valley glaciers varies from year to year and from season to season, but seldom exceeds one to two feet a day.

When the glacier has moved down its valley to a warmer altitude where the rate of melting equals the rate of movement, the glacier establishes a more or less permanent *foot,* or *front,* where it drops its heaviest material. The material transported and deposited by glaciers is called *drift,* and an accumulation of drift is called a *moraine.* If it is deposited at a place where the foot of the glacier stands for some time, it is a *terminal* moraine. If it is deposited by the main stream of ice as the glacier is rapidly melted back, it is called a *ground* moraine. The terminal moraine is apt to be a high mass of material, often forming a dam across the valley, while a ground moraine is a scattering of material unevenly over the surface just as it was deposited by the main stream of the glacier that melted back more rapidly than it moved.

The valleys left by former valley glaciers are usually steep-sided and relatively broad-bottomed (U-shaped). Tributary valleys join the main valley, not necessarily at the bottom level as in water-carved valleys, but often at or near the top level of the former glacier. These are called "hanging valleys" and are common in regions where valley glaciers have diminished in extent. When these U-shaped glacial valleys are submerged by rising ocean levels, they make the characteristic *fiords* of the coast of Norway, British Columbia and Alaska, and southern Chile.

Glaciers and ice sheets exist only under conditions of extreme cold, or heavy snowfall, or both. As climate has varied considerably over long periods of the earth's history, there have been several geological periods when the area covered by ice was much more

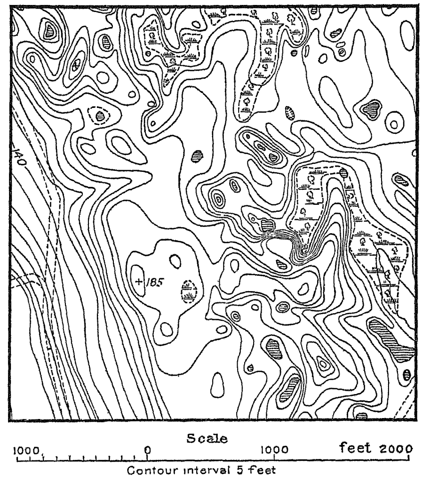


Figure 28 A glaciated area shown on a very large scale. This low but extremely uneven surface with many swamps and ponds is characteristic of many areas where glacial moraines have been deposited (From map by N J Geological Survey in U. S Geological Survey Professional Paper No. 60)

extensive than at present. Then the glaciers in the mountains not only extended far out over the lowlands, but great ice sheets occupied even the lower ground in the poleward parts of the continents and pushed southward to remarkably low latitudes. In the last great glacial period, a great ice cap covered North America as far south as northern New Jersey and Pennsylvania on the east and roughly as far as the line marked by the Ohio and Missouri rivers in the interior. In Europe, the sheet covered the British Isles, Scandinavia, much of Russia, and extended as far southward as Holland and southern Poland. In both continents, the sheet moved outward from a center or centers in the upper latitudes and went through a varied history of advance and retreat until it finally retreated to the small remnants now existing in Greenland and in Scandinavia. The work of these sheets was to pluck materials from the northern lands and carry them southward, smoothing down the major irregularities over which they passed. Several series of terminal moraines were formed at places that marked long-continuing fronts of the ice, and ground moraine was scattered over the surface by the re

treating ice sheet. This ground moraine interfered with the development of a "normal" drainage pattern and trapped the surface waters in countless swamps and lakes. The lake regions of Finland, Sweden, Minnesota, and Wisconsin are due to this phenomenon. The waters from the ice fronts and the retreating ice carved drainage channels and deposited materials which have had a marked influence on the soils and land forms of all areas which were under, or adjacent to, the ice sheet.

Wind in Its Effect on Land Forms. The direct effect of wind on land forms is largely due to its transporting powers. As with running water, the power of wind to transport materials in suspension depends upon its velocity. Wind picks up the fine, loose products of weathering and transports them until they come to rest, at least temporarily, in the lee of some outstanding land form, or until the wind velocity decreases. This transporting effect of wind is most noticeable in areas so dry that little vegetation holds the soil in place and where the marked changes in temperature between day and night tend to break up the surface materials rapidly. In both north-central China and central United States, there are great areas of very fine silt which has been blown from the drier areas to the westward and deposited on the margins of the moister region. This material is called *loess* and usually makes very rich soil.

Waves and Currents. As the waves and currents of the water bodies, driven largely by the wind, beat upon or flow against the shores of the land, they tear at those shores and drag their materials out into the sea. As with the moving waters of the land, the erosive force of waves is due to their velocity, their power to transport, the abrading effect of the materials held in suspension, and their power to dissolve the materials with which they come in contact. Waves, however, because their direction and velocity of movement may vary with every passing breeze, are subject to tremendous variation in their effects. One storm may change the aspect of a whole coast line, may open up new channels and close old ones, and, in general, do more destructive work in a few days than would usually be accomplished in many years. The "normal" forces at work on any coast line are the products of the average weather and currents; unusual and rare storms may add to or counteract the work of years.

Coastal alterations by waves and currents not only interfere with navigation but also destroy and create real estate. For example, Rockaway Point, a barrier beach across the mouth of Jamaica Bay, New York City, has been lengthened one mile in twenty-three years by the addition of sand deposits carried by along-shore currents At the same time, other currents have washed away Duck Bar Island near the mouth of Jamaica Bay.

QUESTIONS FOR DISCUSSION

1. Examine some of the old stone buildings in your neighborhood. What evidence is there of the work of destructive forces?
2. Does each destructive force produce characteristic land forms? Illustrate.
3. How might ocean waves and currents alter the appearance of a submerged coast?

The Complexity of Land Forms

Very few land forms are the product of a single force working alone and uncomplicated by similar or opposing forces. Most forms, even when they are relatively new as the age of the earth is measured, have been subjected to millions of years of weathering.

Mountains are seldom of one pure type, even though they may be designated as *block mountains* (formed by faulting), *folded mountains* (formed by folding), or *volcanic mountains*. Any of these types may be complicated by folding, faulting, or volcanic action and thus become *complex mountains*.

Differential erosion and rejuvenation complicate the older land forms which have been subject to destructive forces over a long period. In addition, the destructive forces deposit the materials which they derive from their destructive activity over the lower lands and in the water bodies to build new forms. Glaciation, of continental proportions, may override all the features of a region, smoothing off irregularities in some instances and depositing an irregular mantle of drift over the plains.

The Topographic Cycle in Streams. The forces of erosion by water are usually the most important in determining the "age" of the topography, so this concept is perhaps best illustrated by the stages in stream development.

Youth. In this stage, the stream is swift flowing and is cutting its bed down into the surface faster than slope wash brings in materials from the sides. As a result, its valley is V-shaped. There is also rapid wear at the source of the stream and its headwaters cut back, thus lengthening its course. Tributaries form, each in itself becoming a youthful valley. If the original surface was essentially level, there will be wide areas of flat-topped plateaus between the stream

courses, and the valleys will appear as ravines in the plateaus.

Maturity. As the process goes on, the rapid cutting down of the bed of the stream will bring it closer to *base level*—that is, to the level of the body of water into which it flows (in most large streams, sea level). This lowering of the gradient decreases the rate of flow of the stream, and wash from the sides is now more rapid than the cutting down of the bed. Consequently, the valley is broadened This widening of the main valley and the tributary valleys reduces the amount of level land between the streams at the old surface level, and there may now be sharp divides which stand up like mountains. In addition, the main stream begins to swing from side to side, widening its valley still further. The slopes become smooth and gentle, the ridges between the streams become rounded, and the valleys become broad and flat bottomed. This stage is called *maturity*.

Old Age. Still further along in the cycle, the bottom is so close to base level that there is almost no downward cutting. The side wash has reduced all of the slopes until even the tributaries are sluggish as they approach the main stream, and the lateral swinging of main stream and tributaries has reduced all but a few of the remnants of the former surface to a plane. Such a plane, produced in the *old age* of a cycle of erosion, is called a *peneplain* ("almost a plain") and is the culmination of the cycle.

It should be noted that, in this stage, the river, because of its low gradient and the large amount of material supplied by its tributaries, is unable at most times to carry all of its load, depositing some of it in the form of bars. The final deposit of the last of this material in the quiet sea waters at the mouth of the river gives rise to deltas and swamps which may change and grow at a considerable rate The lengthening of the stream's course by the addition of deltas reduces its gradient still further and makes it even more prone to deposit, rather than to erode, in its lower course.

Along its sluggish course on the peneplain, the river usually builds *natural levees*. These are formed at flood stage. As the river rises, the velocity is increased because it is carrying an increased quantity of water between its banks. The power of this swiftly flowing water to hold material in suspension is great. The instant the water becomes high enough to spill over the banks, the velocity of the water so spilled decreases suddenly and the heavier suspended materials are deposited on the immediate banks of the stream. Only the finest materials remain to be deposited in the farther reaches of the flood plain The continuance of this process for countless seasons builds up the banks until they become much higher than the surrounding countryside. As a result, the bottom lands away from the river are often swampy or occupied by bayous, because the water, both from floods and rains, has difficulty reaching the main channel across this higher ground. A characteristic of the lower courses of such great rivers as the Mississippi or the Yangtze Kiang is that these natural levees are usually the highest parts of the landscape. On a smaller scale in earlier stages of erosion, this overflow and deposition of sediments accounts for rich, flat bottom lands along the river courses.

Each river system usually has, within itself, representatives of all the stages of the erosion cycle. The headwaters are usually in the stage of youth, the middle courses may be mature, and the lower courses in the stage of old age. Differences in the nature of the materials over which the river flows may, however, alter any of these stages This may lead, especially, to outstanding physical features in the stages of maturity or old age because more resistant rocks have prevented erosion from achieving its "normal" development. Variations in climate also affect the cycle by supplying varying amounts of water with which the stream may do its work.

Rejuvenation. At any stage in this cycle of erosion, crustal movement may give rise to a tilting or folding of the crust which interrupts the cycle or starts it all over again. A peneplain may be uplifted so the gradient of the stream is increased, causing rapid cutting down into the surface for all, or a portion, of its course, thus complicating the features.

The Earth's Surface Materials

Unconsolidated Materials. The loose materials of the earth's surface, derived either from the decomposition of the rocks immediately below or brought from a distance by water, wind, or glacier, are the principal physical constituents of the *soil*. Here, the more important of these unconsolidated soil materials are considered only in the part they play in the formation of rocks. These materials produced by weathering are carried and sorted by the streams and waves and deposited in the form of *gravel, sand, silt*, and *clay*.

Gravel. This is a mixture of small stones varying in size from that of a small pea to that of an orange. The pieces are usually well rounded because they have been rolled against each other and worn by the water. Hard stones such as quartz predominate be-

cause they withstand this process, while the softer rocks have been ground into smaller fragments.

Sand. Still finer sediments, usually about the fineness of granulated sugar, are called sand. The individual grains are hard enough so they do not stick together when wet. This material is also composed largely of quartz grains, because the softer materials tend to compact when damp.

Silt. This material has grains as small as those of sand, or smaller. The main difference between silt and sand is that the former is made up largely of grains of silicates and hydroxides.

Clay. The grains of clay are of the very finest and are deposited only in very quiet water. These grains are not only finer than those of silt, but they also differ from them in chemical composition. There are large quantities of alumina present which tend to bind the grains in a solid mass

The Sedimentary Rocks. The consolidation of these sediments into rocks is due to pressure and to cementation. The pressure arises from the weight of the materials above as the deposit deepens. The cementing materials—such as iron oxide, calcium carbonate, and silica—come either from water trapped with the sediments when they are deposited or from the percolation of ground water. The hardness and compactness of the rock within a given classification tend to vary with its age.

The nature of the rock which results from these sediments depends upon the materials from which it was made. The following list indicates the type of rock resulting from each class of sediment:

Sediment	*Rock*
Gravel	Conglomerate
Sand	Sandstone
Mud (silt and clay)	Shale
Mud and sand (containing considerable calcium)	Limestone

These types of rock are seldom pure and the classes are not mutually exclusive. Conglomerates grade into sandstones, and the latter into shales. There are also shales which are highly calcareous and are, therefore, difficult to differentiate from limestones. Usually the sandstones, limestones, and shales are composed of relatively fine grains and make a more or less compact and uniform rock. The conglomerates, on the other hand, are composed of various sizes of pebbles and boulders cemented together.

Stratification. Because they are carried, sorted, and deposited by water, sediments of one kind and size tend to be laid down together. Because they are usually deposited on the shore or floor of water bodies, they tend to be laid down in horizontal, or nearly horizontal, layers. Such a layer is called a *stratum,* and the rock is said to be *stratified.* Minor horizontal divisions are called *beds.*

The Igneous Rocks. Volcanism brings up to, or near, the surface molten materials from the earth's interior. The rocks produced when these materials cool and harden are tremendously varied in their chemical composition, texture, structure, and hardness. These qualities usually depend on the rate of cooling and the conditions under which the rocks were deposited. Igneous rocks are usually not stratified and are usually harder than the sedimentary rocks. Those igneous rocks occurring most widely include granite, quartz, and "traprock" (diabase or basalt)—all rocks of great hardness and wide economic use. *Lava* is a name given to any igneous rock which has been deposited on the surface of the earth.

The Metamorphic Rocks. *Metamorphic* means *changed in form* and the rocks of this class are merely igneous or sedimentary rocks which have been changed since their formation. The principal agencies producing these changes are contact with molten igneous rock and compression due to folding or to the weight of the rocks above. The heats generated by these forces materially affect the texture and structure of the rock and sometimes turn it into a product which does not bear the slightest outward resemblance to the original material. Common examples of metamorphic rock and the rocks from which they are made are indicated in the following list.

Original Rock	*Metamorphic Rock*	
Sedimentary		
Conglomerate	Gneiss	These may also metamorphose into some form of schist
Sandstone	Quartzite	
Shale	Slate	
Limestone	Marble	
Igneous		
Granite	Gneiss	
Felsite and tuff	Slate and schists	
Basalt and gabbro	Hornblende schists and serpentine	

The metamorphic rocks are usually harder than the sedimentary rocks and often harder than the igneous rocks.

QUESTIONS FOR DISCUSSION

1. Analyze the topography in your county. Is it young, mature, or old? Compare the topography near the main streams with that in the tributary valleys.
2. Would old mountains and very young plains appear about the same? How might they be distinguished?
3. Would the topographic cycle be the same in an arid region as in a humid region?

CHAPTER 6

MAN AND LAND FORMS

"MOUNTAIN" is a relative term, not only as to height, but also as to environment. In a region of low relief, an elevation of a few hundred feet may be called a mountain and, because of the scarcity of such features, may be very important, locally. In a region of considerable relief, a feature rising several thousand feet may be called simply a "hill" and be relatively unimportant in its effect on local economy because it is a minor feature in a region of larger ones In the preceding chapter, it was pointed out that height alone was not sufficient to account for the barrier effect of relief features and that steepness of slope was very often of more importance.

Life in Mountains

Mountainous regions in all parts of the world tend to have essentially similar industries and uses of land. Above the timber line, the land may be useless, or good only for seasonal pasture Lower down, the slopes are covered with forests; still lower, with orchards, vineyards, and pastures; while field crops may occupy the valley bottoms and the gentler slopes. In many instances, mine workings and dumps scar the hillsides. Tourist hotels and scenic routes tell of recreational activities. Out of such regions may come handicraft articles such as wood carvings, lace, embroidery, and other manufactured articles requiring high skill and small amounts of raw materials. Reservoirs and powerhouses indicate the harnessing of the swiftly flowing streams. While these means of utilization may vary in detail because of differences in position, climate, mineral resources, or cultural background, their essential character is so similar that it may be safely concluded that these activities are present because the regions are mountainous.

The Principle of Limits and Optima. The mountains are not *physically* the best places for some of these activities. Forests, for instance, grow better on the deep rich soils of the level plains. Cattle would be fatter on the rich pastures of the plains or in agricultural districts where their food may be raised more easily. But the physical conditions in mountains do *permit* these activities to be carried on there and they rule out specialization on field crops which require large areas of level land and deep rich soils. In other words, the mountains lie within the *limits* for grazing and forestry, but not for the raising of many of the field crops. *The limits include all that land having at least the minimum physical conditions necessary for a given activity.* There are not only limits for an activity, but also limits for each of the physical requirements of that activity; that is, there are rainfall, or soil, or temperature limits for any given crop. The rainfall limits would include all the land having at least the minimum amount of rainfall required for that crop. However, land may be within the rainfall or temperature limits for a crop, but may not be within the *total* limits because it does not have the minimum soil requirements.

Within the limits lies an area called the *optimum, which has the best physical conditions for carrying on the activity.* The optima for the growth of field crops and the grazing of cattle may be the same, but the limits for field crops are narrower than those for grazing, so field crops will tend to be raised on the better land until the demand for those crops is met and only surplus land, if any, within the optima will be used for grazing. Of course, there are other important factors which influence the distribution of activities and crops, but this elementary concept that the activity with the narrower limits tends to get the better land is very significant. It results in many activities being carried on, not in the areas with the best physical conditions for them—that is, their optima—but in regions where they—and almost nothing else—can be carried on. Thus, the mountains are not the best places for grazing or forestry, but grazing and forestry are among the best uses for mountains.

The Characteristics of Mountain Economies. Most of man's occupations in mountainous regions represent adjustments to the difficulties of transport. This handicap is both local and with respect to mar-

ket. The difficulty of getting about, even on one man's holding, places a premium on uses of land which require the least human travel and the minimum transport of goods. Animals and tree crops meet this requirement very well. The animals, under their own power, walk about to the isolated areas of pasture and, themselves, bring in to the farm the milk, meat, or wool they have "harvested" from the scanty vegetation of the steep slopes. Timber is cut but once in a considerable span of years and requires little care during the period of growth and, therefore, little travel and transport on the part of man. The difficulty of using even such simple agricultural machinery as the plow or harrow on the steep slopes also tends to restrict the raising of field crops beyond the minimum requirements for home consumption.

If a mountaineer is attempting to produce for a distant market he must produce articles which have large value in proportion to their bulk because transport to market is often expensive. The prevalence of illegal distilling in certain mountain districts is undoubtedly due, in part, to the temptation to refine the product of an acre of corn or an apple orchard so that it may be put into jugs and transported cheaply in a region where carriage of the bulk raw material would be expensive. This also accounts in part for the making of articles—such as wood carvings, lace, and watches—in which the finished product is very valuable in proportion to its bulk. The manufactures of Switzerland are of this type.

This very difficulty of transportation acts as a protective tariff in reserving much of the local market, such as it is, to the local producer. His costs of production may be higher than those of his competitor in the plains, but his nearness to the local market cuts down the high transportation costs. The modern regional division of labor which owes its very existence to ease of transport is, thus, less important in rugged regions. This undoubtedly accounts for the survival of pioneer types of self-sufficient economy in mountains.

Rugged relief not only restricts the *kind* of production that may be carried on, but it also limits the *amount* of production. Soil is commonly poor on slopes because erosion is rapid. If there is some flat land with fairly rich soil in the valley bottoms, it is apt to be scattered in small fields. Thus, a farm in the mountains and one in the plains might even have the same number of acres of equally rich land and yet the mountain farmer be at a disadvantage because his fields are small and not continuous, thus discouraging the use of machinery and forcing him to travel and to haul seed and harvest much farther in proportion to the yield. The force of this handicap and, indeed, of all the handicaps expressed as being inherent in mountain environments, will vary with the "age" of the topography. In old mountains with wide valleys and gentle slopes, much of the land may be admirably suited to field crops and give high yields. In young mountains with their narrow valleys and steep slopes, good land will be scarce and field crops to supply local needs may have to be raised on steep slopes and, therefore, involve the use of poor soils with the consequent necessity of putting in more labor and fertilizer in proportion to the yield. In mountainous parts of the Orient—notably in Japan—good land is so scarce in proportion to the population that hillsides have been carefully terraced at tremendous expenditures of labor.

In general, the grazing and forestry common in mountains are not high-yield uses of land. The income is not high, either in proportion to the amount of land used or the labor involved, and costs of marketing are high. Thus, the level of prosperity is low in really mountainous regions, except where mining or the tourist trade has developed.

Mountain Society. Many modern social conveniences can be of any considerable use only to people living in large groups. Isolation means not only distance from the neighbors, but also distance from the doctor, the hospital, the church, and the school. Even where mountain regions are but parts of otherwise advanced political units, provisions for schooling are poor. In a recent study [1] of social conditions in the southern Appalachians, it was found that

> The general attitude of school authorities seems to be that since there is very little taxable wealth in these isolated sections, the county cannot afford to maintain schools for them. The number of children among isolated families at any single point is often very small, but their total number is considerable. Poor roads prevent the operation of school busses, and in many other ways it is a most difficult problem, economically, to bring education to these homes.

In these mountains, "some localities are fifteen or more miles by air line from a physician and perhaps twice that far over roads which, except under favorable conditions, cannot be travelled by automobile." [2] Again, "some localities are as much as fifty miles from a general hospital and much farther if the ordinary routes of travel are followed." [3]

[1] *Economic and Social Problems and Conditions of the Southern Appalachians.* United States Department of Agriculture Miscellaneous Publication, No. 205, p. 113.
[2] *Ibid.*, p. 157.
[3] *Ibid.*, p. 160.

The mountains have been, from time immemorial, the home of the personal and family feud. This has been true of Scotland, Corsica, Albania, and the Caucasus as well as of our own southern mountains. It is due in large part to the necessity for self-settlement of disputes and wrongs because of isolation which prevents the invocation of civil and criminal law. Family feeling is strong in a region where the family is apt to be the largest unit of social effectiveness, and the family tends to protect and avenge its own.

Mountains as Barriers. The influence of mountains is not confined to the people living among them, but may be extended over wide areas because of their importance as barriers. Alexandre Dumas remarked that "Africa begins at the Pyrenees," thus pointing out the power of these great parallel folds to differentiate the vegetation, races, culture, and history of the Iberian Peninsula from those of France.

The barrier effect in these, and many other, ranges depends not only on height of the mountains, but also on the presence, height, and distribution of passes (which in turn is often dependent on the age and extent of erosion), and on the width of the mountain zone. The origin of the mountains is also of importance. The alternate ridges and valleys of the folded Appalachians offer a more or less continuous highway, north and south, but a marked barrier to commerce east and west. Many of the isolated volcanic peaks standing upon the broad Mexican Plateau, on the other hand, are often easy to avoid and offer little barrier to passage in any direction.

The distribution of passes, because they control the avenues of trade through mountains, frequently has an influence far beyond the mountains. The Hudson-Mohawk gateway through the Appalachians settled the Great Lakes region with people from the northern states. The headwaters of the westward-flowing Ohio, however, interlaced with the headwaters of eastward-flowing rivers as far south as the Yadkin in North Carolina and gave to the Ohio Valley a large population of southern origin, a fact which has been of marked political and economic significance all through the history of the region.

QUESTIONS FOR DISCUSSION

1. Is a narrow mountain region between two progressive areas likely to be economically backward?
2. How does rugged relief influence the amount and kind of production in agriculture? in manufacturing?
3. Look up, in a large atlas, the location and relief of Liechtenstein, Andorra, Nepal, and Bhutan. Does relief partially explain their independence?

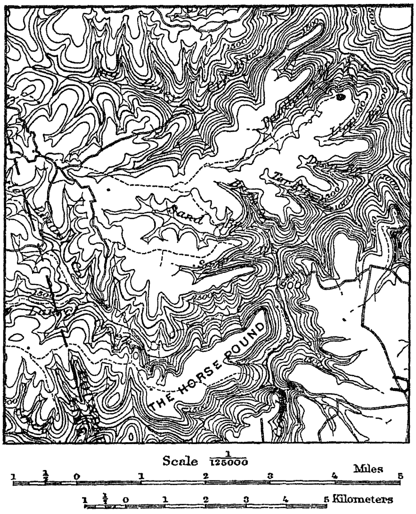


Figure 29. "Mountain White Country." Note the young valleys, and the position of the few houses (black squares), trails (fine intermittent lines) and roads (double lines). Why are these features concentrated on the uplands? (From U. S Geological Survey, Standingstone, Tennessee, sheet)

Some Advantages of Mountains. Mountains are not exclusively regions of unfavorable environment. In the tropics, the decrease in average temperature with increase of altitude makes many of the mountainous regions much more satisfactory environments than the steaming lowlands. In the Republic of Colombia, for example, most of the people live in the mountains and plateaus.

The tendency of cold air to settle to lower levels protects plants on slopes in the upper middle latitudes from late frosts in spring and early frosts in autumn This is called *air drainage* and accounts in large part for the location of vineyards and orchards on mountain sides.

Water power is often great in mountainous regions because the streams are swift and fall considerably in a short distance. Valleys penetrating into mountains—or plains adjacent to mountains—are often good sites because of the excellent water supply for power, irrigation, or domestic use.

The scenery of mountains, their isolation, and the climate attract tourists for rest and recreation. Often, in the midst of densely populated areas of rich land, a small island of mountainous country will exclude all intensive uses for the land and provide a region suitable for park land and recreation purposes where it is most needed.

The difficulty of transport and communication in mountains may be an asset because it makes mountains easy to defend. The mountaineer has long had a reputation for independence of spirit, and freedom has been considered a mountain virtue, partly because of the necessity for self-reliance imposed by the nature of the terrain. At the same time the mountaineer has been aided in his fight to maintain his freedom because the topography was fighting on his side.

Mountains and Minerals. Mining is a common occupation in mountainous regions because the forces which create rough topography tend to concentrate or expose minerals. Most of the minerals are widely dispersed through the earth and perhaps were, at one time, relatively evenly distributed. In order to form a commercially profitable ore body, something must have happened to concentrate the minerals. One of the commonest forces of concentration is the volcanic action which contributes to the building up of land forms. In any molten mass there tends to be a rearrangement of the materials with respect to their gravities, their specific heats, and the rate and temperature at which they crystallize. This means a gathering together of like substances and, when the lava cools, it is often found that a very thorough job of concentration has been done. The prevalence of ore bodies, especially of the metals, in volcanic regions is, therefore, not surprising. There are many other methods by which concentration comes about, but some of the more important—notably that due to erosion and deposition—tend to rob the mountains of their minerals and deposit them in low places and in water bodies.

The mountain-making forces have an important effect on the use of minerals in that they expose them and make them available. Folding and faulting bring deep-seated deposits to the surface, and the erosion of deep valleys and canyons by running water may expose a considerable section of the underlying strata and make any deposits included in these strata available. This is especially important in an area where rejuvenation, due to crustal movement, causes the streams to cut down into territory where mineral elements have already been sorted out and deposited by the streams in a former cycle of erosion.

Islands—The Mountains of the Sea

Islands are the tops of the hills and mountains in the sea. They give rise to many human adjustments like those in mountains and, often, there exists the same isolation of one small group of people from another and from the rest of the world. The barriers to communication, however, are weather and sea rather than topography. As geographic laboratories islands are of especial interest since their boundaries are definite, and differences in culture between two islands only a short distance apart may illustrate, in a striking manner, differences in adjustment that may exist when position is similar, but site factors are different.

Site Factors in Islands. The only physical characteristics which islands have in common are due to all islands being surrounded by water. This makes insular temperatures milder than those of the large land masses in the same latitude and makes islands on their windward shores subject to the influence of the unbroken sweep of the wind off the sea. Water is so much a part of the island dweller's environment that it may also lead him to turn to the sea for some, or all, of his subsistence. Fishing and the transportation of goods by sea, both for himself and for others are common adjustments to his watery surroundings. The fullest use of the sea for livelihood does not necessarily follow, however, since other elements in the local environment may make other occupations more profitable, or cultural factors may minimize the attractions of the sea. Islands with fair soil and mild climate—such as Jersey and Guernsey in the English Channel—may become the home of farmers who consider the surrounding sea but a barrier to marketing their products and a source of fish to add variety to their diet Barren or mountainous islands with fair harbors—such as the Shetlands or Orkneys—may, on the other hand, push their people toward the sea as the easiest avenue to a livelihood. It is the infinite variety in the economies of islands, due in large part to variations in their local environments, that make them such fascinating studies in human geography.

The nature of the island shore line and the presence or absence of good harbors are environmental factors of the utmost importance. If deep and sheltered harbors are available, large boats may be maintained and, thus, access to the riches of the sea and communication with neighboring and distant regions

be possible in almost any weather. If, on the other hand, there are no harbors because the coast is too rocky, or because of a gradually sloping sand bottom constantly pounded by breakers, the people may be almost as landlocked as those of a mountain valley and must find their living from the land.

Position Factors in Islands. The total environment in an island, as in any other geographic unit, includes position factors as well as those of site. The sea may be either a barrier or a highway. Islands with good harbors close to areas of dense population are often utilized intensively, and the surrounding water acts as a connecting link rather than a cause of isolation. Long Island, being close to the metropolis of New York, has most of its utilization determined by its position. In a like manner, the Isle of Man—in the Irish Sea between England and Ireland—would be a region of low-grade agriculture if it had to live entirely from its site advantages, instead of being a recreational area for the millions of people living in the crowded industrial districts of near-by England. If the Hawaiian Islands were two thousand miles south of their present position, they would be out of the principal steamer lanes and would probably be of no more world importance than Tahiti is at present. The change from coal to oil as the principal fuel of ocean-going commerce has removed most of the traffic which formerly called at the Virgin Islands for coal and resulted in a marked decrease in their prosperity and importance.

Isolated islands, even if they are rich in terms of local environment, tend to be subject to the same social and economic results of isolation found in many mountainous regions. In the islands west of Ireland and Scotland and those off the coast of Maine, doctors are few and widely scattered, and hospitals are far away. Distance from markets puts a premium on a self-sufficient economy, and social and cultural conservatism characterizes such islands.

The Importance of the Size of the Unit. The size of an island and the number of people it will support are of great importance in determining the influence of its insularity. If it be as large as Australia—large enough to contain within itself a variety of production and the population to receive the social advantages which are available only to large groups—it loses most of its insular character. On the other hand, in moving some of the population from the small island of Inishturk off the Irish Coast, the government took great care that there would be enough people left to be of mutual assistance and to furnish the necessary diversity of skills.

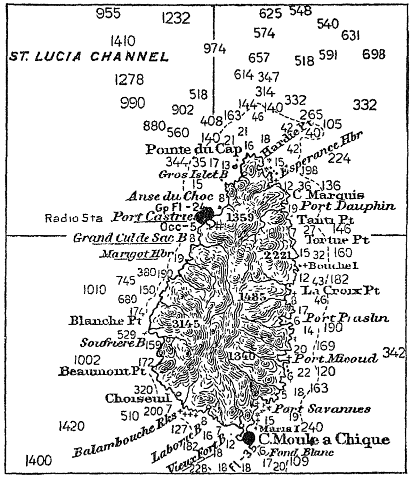


Figure 30. Map of the volcanic island of St. Lucia (West Indies). St. Lucia is literally a mountain peak arising from the sea. The figures indicate height (in feet) on the land and depth (in fathoms) in the sea. Notice how sharply the depth increases away from shore. Note also how contour lines are used to suggest relief. The scale is about 1:1,000,000, but as this is a Mercator's projection it is only approximate. (From U S. Hydrographic Office Chart, No 2319)

Peninsulas. The word *peninsula* means "almost an island," as does the French term for the same feature —"presqu'île." The German word is "halbinsel," or "half island." Implied in these several terms is the fundamental fact that there is much of the insular in the condition of a peninsula. This is especially noticeable when the landward end of the peninsula is separated from the continental mass by a mountain barrier, as in the Italian and Iberian peninsulas The people of the Scandinavian peninsula could hardly feel the influence of the sea more if they were completely surrounded by water Most of the European continent is subject to similar peninsular influences. In fact, Europe has been called "a peninsula of peninsulas."

QUESTIONS FOR DISCUSSION

1. Are the Rocky Mountains advantageous or disadvantageous to the United States?
2. Is isolation on islands generally as difficult to overcome as in mountains?
3. Is Great Britain small enough to have the economic characteristics of an island? Illustrate.

Life in Plateaus

The dictionary definition of a plateau as "a broad, level, elevated area of land" hardly fits the actual topography in most of the world's plateau areas. A region is called a plateau not only because it is high, but because, on at least one side, it stands out as distinctly higher than some adjacent area. Thus, the Piedmont Plateau in eastern United States is so designated because it rises in a distinct "step" up from the Atlantic Coastal Plain on its eastward margin. This zone of break is called *the Fall Line* because it marks a zone of falls or rapids in the rivers flowing from the Appalachians to the Atlantic.

Neither is it true that a plateau is necessarily level. Plateaus vary in topography from high featureless plains to conditions where the plain is cut up by numerous canyons—as in the Colorado Plateau—or to conditions where block or folded mountains or volcanic cones rear their heights above the general level—as on the Mexican Plateau. In general, however, plateaus are characterized by large areas of relatively flat land at the top level of elevation. Plateaus may be uplifted peneplains into which the rejuvenated streams have begun to intrench themselves, or they may be but the isolated remnants of the old peneplain still standing between the stream valleys. Such remnants are often called *tablelands* and, in the United States and Latin America, when they are small in area are referred to as *mesas* or *buttes.*

A highly dissected plateau may have all the characteristics of mountains in the prevalence of steep slopes and the scarcity of flat land. Much of the region in eastern Tennessee and Kentucky which the layman calls the "Southern Appalachian Mountains" is, actually, a highly dissected plateau and the physiographer prefers to call it the "Appalachian Plateau." On the other hand, a really level plateau has most of the topographic influences of a plain. In such an area, only the isolation due to rough topography at the rims of the plateau or the climatic effects of elevation are important in differentiating human responses from those in plains.

Plateaus and Climate. The climatic difference between lowlands and plateaus in the same latitude is most noticeable in the tropics. Due to the decline in average temperature with increase in elevation, Kenya and Rhodesia, in Africa, and the Bogota and Brazilian plateaus, in South America, are considered "white man's country," while lowlands in the same parts of the world, because of their tropical heat, are generally avoided by the white race. The higher parts of the Andean and Tibetan plateaus are too cold for the growth of any but the hardiest vegetation and are used mostly for pasture.

Plateaus are often drier than neighboring lowlands because the rim of the plateau or surrounding mountains wrings most of the moisture out of the winds. As a result, steep-sided canyons and other sharply defined, dry-land features are often characteristic of plateaus. The Grand Canyon of the Colorado River and such canyons as that of the Snake constitute barriers to communication between the flat areas on opposite sides of the rivers.

Plateaus whose rims do not shut out the rain-bearing winds are usually subject to rapid erosion because of their elevation and develop rapidly (as geologic time is measured) into hill country in a late stage of erosion. This is thought to be the origin of the hill lands in eastern and southern New England, which are supposed to be the remnants of an old peneplain. Life in such a plateau is similar, in its adjustments to topography, to that in other hilly country.

Intermontane Basins and Interior Drainage. High, relatively level areas completely surrounded by mountains are sometimes called "plateaus," although the term *intermontane basin* is to be preferred. Unlike most true plateaus, the surrounding lands are higher than the levels between, and the basin, or so-called plateau, itself, is being filled by sediments from the mountains rather than being eroded by its streams. Many such basins are areas of *interior drainage,* that is, the streams which rise in the surrounding mountains flow out onto the floor of the basin, often into lakes or swamps which are salt because there is no escape for their water except through evaporation. In the United States, such a condition exists in the Great Basin which lies between the Rockies and the Sierra Nevadas on the east and west and between the Columbia and Colorado plateaus on the north and south. The Great Salt Lake, in Utah, is but the largest of the many bodies of salt water which mark this region of interior drainage. The Tarim Basin in Chinese Turkistan and the Lake Titicaca Basin between two ranges of the Andes in Bolivia are similar forms. Such areas are usually arid or semiarid because the surrounding rim shuts out rainfall. They are often irrigated from the streams near the foot of the surrounding rim—as in the settlements along the foot of the Wasatch Range in Utah. Farther out on the floor of the basin the soil is likely to be filled with harmful mineral salts which make it useless. These salts may also permeate the available water and make it unsuitable for irrigation use. Such deposits of salts

and other minerals brought down by the streams from the mountains over a long period of time are often of great commercial value. This accounts for the deposits of nitrates in the intermontane desert in northern Chile, and the borax deposits in California.

Life in Plains and Broad Valleys

In plains and broad valleys, the influence of the topography on human activities is largely *permissive* and the differences in human adjustments to the environment in such areas are largely due to differences in soil, climate, minerals, and position or to cultural factors. In such regions, however, small variations in relief may be of considerable local significance because they are scarce. Thus, in the Middle Ages, small local elevations were often used as city sites because of the ease of defense.

Plains and Climate. Large flat areas of land have an influence on climate merely because they are flat. Usually, there is an unbroken sweep of the wind from all directions, allowing cold or hot waves to extend far toward the lower or higher latitudes, depending on the wind directions, or allowing the modifying influence of the sea winds to penetrate far into the interior. The wind is such an important part of the climate on plains that windbreaks of trees are often planted on those sides of dwellings or fields from which the most damaging winds may be expected.

Interior plains are often arid or semiarid, either because surrounding mountains shut out the moisture, or because distance from the sea is great. Great plains extending far inland from the coast tend to grow progressively drier toward the heart of the continent. Thus, across the great European plain, Poland tends to be drier than Germany, and Russia drier than Poland. In general, variations in climate between one part of a plain and another are gradual. The pastoral nomadism so common on plains is not necessarily due to the plain itself. It is rather an adjustment to semiarid conditions and may be found in dry areas of rugged relief.

Life on Flood Plains and Deltas. Many of the great flood plains and deltas are areas of the most intensive agriculture and dense population. The silts deposited by the rivers are usually rich and are subject to further enrichment with every flood. If the rainfall is low, the rivers offer water for irrigation. In addition, the broad, slowly flowing streams are available for boat traffic and the flat flood plain (unless swampy) offers little barrier to communication in all

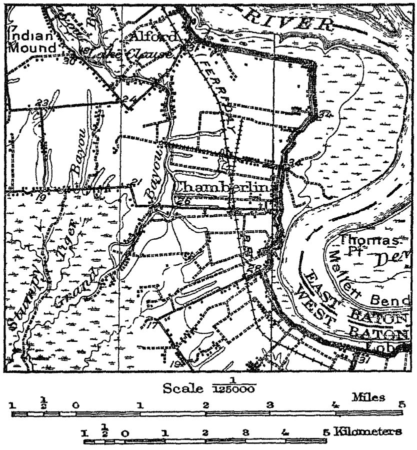
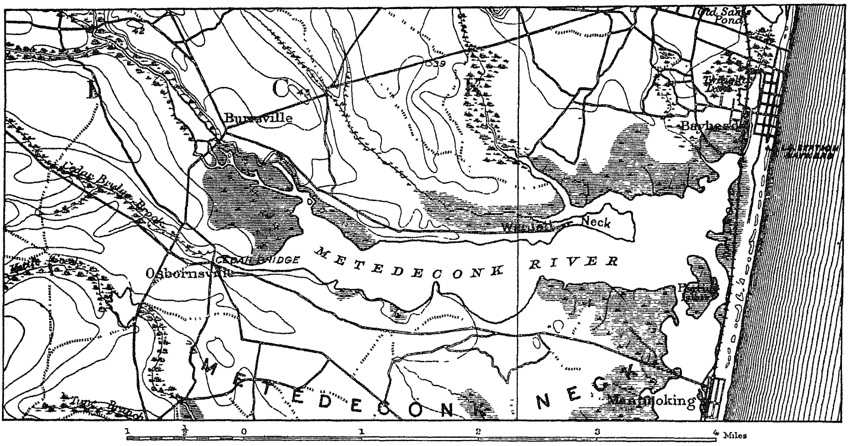


Figure 31. Part of the flood plain of the lower Mississippi River The settled area is on the natural levee between the river and the swamps. Man has considerably reinforced the natural levee in a line roughly parallel to the river Note the very heavy band which indicates this artificial levee. (From U S. Geological Survey, Bayou Sara, Louisiana, sheet)

directions. The deltas and valleys of the Ganges-Brahmaputra, the Yangtze Kiang, and the Hwang Ho are classic examples of all these characteristics.

The great problem of such areas is usually the control of water If irrigation is the prime need—as in the Nile Valley—the equitable distribution of water among the various users may be uppermost in the minds of the people. In almost all such regions, floods are a constant danger and flood control and drainage are among the greatest problems to be solved. The Hwang Ho has built its natural levees high above the surrounding flood plain. When they break, its flood covers wide areas for long periods of time. The river has been called "China's Sorrow" because of the recurrent flood toll of lives and property.

The distribution of population and human use of the land in flood plains is often controlled by relatively small relief features. For hundreds of miles along the lower Mississippi, almost all of the towns and farmsteads are on the natural levees—the highest part of the landscape—and the farms extend out in long strips into the bottom lands. Much of this bottom land is useless because of the difficulties of drain-



Contour interval 10 feet.

Figure 32 A part of the coastal plain of New Jersey (Asbury Park, New Jersey, quadrangle, U S. Geological Survey). Originally this was an emerged coast. After the streams had carved valleys in the plain, the area was partially submerged and the sea covered the lower parts of the valleys. Swamps, tidal marshes, and broad estuaries resulted from this submergence. More recently currents have transported sand along the shore and formed barrier beaches which almost block many of the streams.

age into the *higher* river. Great cities on the immediate flood plains and deltas of great rivers are few and are maintained under difficulties. The rivers are constantly changing their courses, and land above the danger of flood is scarce. In the lower Mississippi Valley, most of the larger cities are located in the few places where the river, in its meanderings, washes against the bluffs bordering the flood plain. If the United States had the population density of China with the associated pressure for land, most of the swamp land of the lower Mississippi would be drained and used, in spite of the cost and the flood danger.

Life on Coastal Plains. Plains which have but recently emerged from the sea bottom—such as the coastal strip of the eastern United States from Massachusetts around to Texas—have certain influences on human life which are due to their origin. Such plains continue to be of decidedly low relief, even when they have been subject to erosion for a long period, because they are everywhere so close to base level that streams cannot cut very deeply into them. The slight variations in local relief give rise to numerous swamps and ponds—as in the Dismal Swamp, on the border between Virginia and North Carolina, or the Everglades, in Florida. Millions of dollars have been expended on drainage in coastal plains in order to control mosquitoes and to reclaim land. In Massachusetts and New Jersey, these swamps have been profitably used for the commercial production of cranberries.

The fact that most of the surface material of coastal plains was laid down under sea water leads to a wide variety of soil types, often in a belted arrangement, parallel to the coast line and representing differing depths and conditions of deposition on the former sea bottom. This often gives rise to a belted distribution of land use—as in Texas, where the procession inward from the coast is as follows:

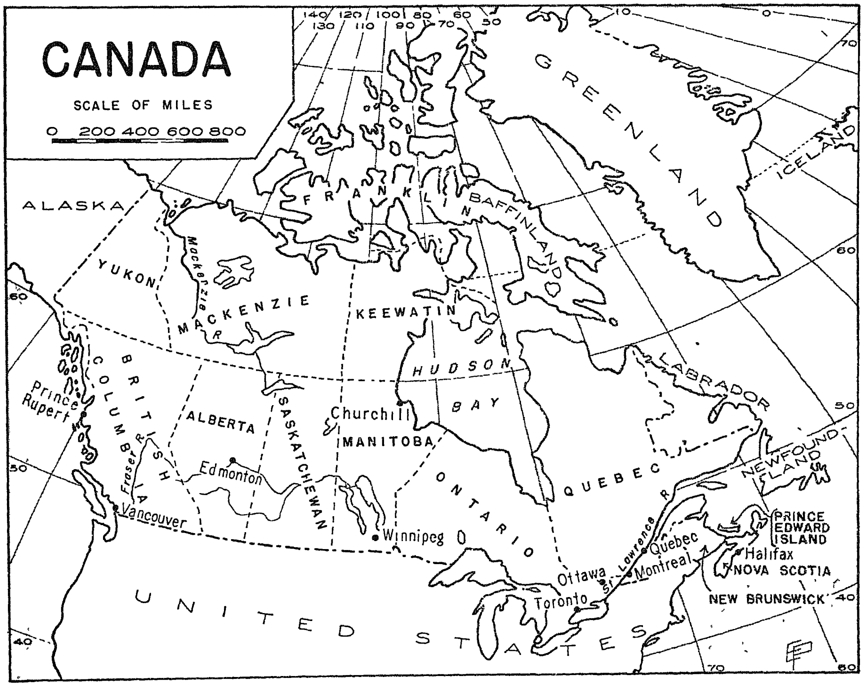
1. The immediate coastal region of barrier beach, lagoon, and swamp.
2. A sandy area of poor grazing land or open pine forest.
3. A strip of "black waxy" prairie, which has one of the best cotton soils, which is due to the disintegration of a black limestone of recent marine origin.
4. Another narrow area of sandy grazing and forest land with some small cotton production.
5. A second belt of "black waxy" soil which is intensively used for cotton and other crops This area is the most densely populated part of Texas and includes the cities of Austin, Waco, Dallas, and Forth Worth.

Glaciated Plains. Plains which have been glaciated usually have characteristics which set them apart from

unglaciated areas. Because of the variety of materials which were carried by the glacier and the variety of conditions under which they were deposited, soils and other surface materials vary sharply, even within a small area. This may give rise to a very "patchy" distribution of agriculture and settlement Swamps and lakes often dot the glaciated plain, offering means of transportation by water—as in Finland—and storage reservoirs for power developments. The small differences in topography, due to the distribution of ground or terminal moraines, greatly influence the distribution of highways and the use of land. Most of the area between the Ohio River and the Great Lakes in the American Middle West (to be discussed in Chapter 40) is a glaciated plain and offers a fine example of such features. A similar glaciated plain extends across northern Eurasia from the Netherlands to Siberia, and morainal ridges, glacial lakes, and glacial soils are major factors in localizing human activities.

QUESTIONS FOR DISCUSSION

1. Consult a road map of the United States, or some other area of varied topography Find specific examples of the influence of each type of relief on roads.
2. Is a plateau likely to have greater relief than a plain? Why?
3. Would a fertile plains area of moderate size, hemmed in by high mountains (with several low passes), be a good site for a developing civilization? Might a desert be as great a barrier as high mountains?



CHAPTER 7

TEMPERATURE

CLIMATE is, perhaps, the most striking aspect of the physical environment. Man is so conscious of climatic and weather phenomena that it requires no urging to convince him that they are important. He discusses weather and climate more often than any other element of his environment. This is probably because the state and changes of atmosphere are obvious, even to the casual observer, and he is vitally aware of their effect on his comfort and activities.

The influence of climate on agriculture, grazing, and transportation by land and sea is direct and obvious. There are many aspects of climate, however, which are not so obvious. Among these is the effect on man's mental activities and attitudes which has been so profitably investigated by Dr. Huntington (see pages 9-11). In addition, climate exercises a marked effect on all aspects of economic life, although its influence is often indirect. Much of the world's population, commerce, and production have been adjusted to climatic factors for so long that the adjustment is not immediately apparent. Weather catastrophes—such as droughts, floods, cold waves, and exceptional hot weather—often bring this out in a striking manner. They are disastrous because they are unusual. In other words, the climate in most regions of dense population is generally favorable (otherwise the population would not be dense) and man has found this out and adjusted himself accordingly. The unusual weather is important because it departs from this generally favorable condition.

Weather and Climate Defined. *Weather* is the condition of temperature, pressure, humidity, precipitation, sunshine, and wind at a given moment or for a single day. The *climate* of a place or region is, on the other hand, the average of these conditions over a long period of time. That is, the description of the climate of a place is possible only if there are exact records of all these atmospheric phenomena over a long succession of years. The mathematical average of the data for each item is taken and the result is a picture of the average conditions, or the climate. In some climates this average will be a description not only of the general condition, but also of the condition which will actually occur, day by day, for the majority of the days. In such a climate there is little *weather element,* little variability from day to day or from year to year. In conditions such as those in the northeastern United States, or the Middle West, the weather is so changeable that the *average* temperature, snowfall, or sunshine will seldom, if ever, actually occur because it is merely a mathematical mean between widely varying conditions. The common misconception of climatic changes in regions where the weather element is important is due to the average person's inability to keep in mind all the varying conditions and come to an adequate picture of an average. He is capable only of retaining outstanding weather impressions, and even these do not remain accurate for any length of time. The degree of variability, or the *weather element,* in any climate needs to be taken into account to arrive at an accurate description.

Temperature

The temperature of the air as indicated by an ordinary thermometer is called the *dry-bulb temperature.* If the bulb of the thermometer is covered with a constantly moist piece of muslin, the thermometer becomes a *wet-bulb thermometer.* The *wet-bulb* temperatures indicate more accurately than the dry-bulb temperatures how hot the weather feels because the moisture evaporating from the muslin jacket cools the wet-bulb in the same way that the evaporation of perspiration cools the skin.

Sensible Temperature and Relative Humidity. The *sensible temperature* is how hot or cold the surrounding atmosphere seems to an individual. It is difficult to measure, not only because it is affected by the relative humidity and the movements of the air, but also because it varies from individual to individual and from race to race. The most important element in the sensible temperature, other than the dry-bulb temperature, is the *relative humidity,* which

may be defined as *the amount of water vapor in the air in proportion to the amount that the air can hold at that temperature.* The general rule is that warm air feels warmer and cold air feels colder if the relative humidity is high. When very high temperatures prevail, the body is cooled by the evaporation of perspiration from the skin. If the air is dry, it can absorb this moisture and cool the body. If the relative humidity is high, the perspiration is not absorbed and the same dry-bulb temperature may *feel* warmer. When very low temperatures prevail, the body is not perspiring and it loses heat to the surrounding atmosphere, not by evaporation, but by *conduction,* or the direct transfer of heat from the molecules of the body to the molecules of the air. Humid air is a better conductor of heat than dry air, so the body loses heat more rapidly, if it is not perspiring, when the relative humidity is high.

The Sun the Main Source of Heat. While a certain amount of heat is given off by the earth independent of its acquisition of heat from outside sources, this amount is so small as to be negligible and, for all practical purposes, the sun may be considered as the sole source of heat in the world's atmosphere.

Although, ultimately, the heat of the earth's atmosphere is derived from the sun's rays, three processes of heating and cooling determine the effectiveness of the sun's rays in controlling temperatures. These principal means by which heat is distributed throughout the atmosphere, the soil, and the waters of the earth are *radiation, conduction,* and *convection.*

Radiation. The sun gives off heat waves from its surface and heats the earth and its atmosphere without heating the great void between. This radiation from the sun is fairly constant. The fluctuations in its intensity are much less important in explaining the heating of the earth than changes in cloudiness and in the position of the sun. Nevertheless, exact measurements of solar radiation indicate that its intensity changes significantly from time to time. Although the exact effects of these changes have not yet been satisfactorily determined, it seems probable that they may be the ultimate cause of droughty periods and similar abnormalities in the weather.

The earth also radiates its heat (received by radiation from the sun) back into its atmosphere, thus warming the latter and cooling itself. The rate at which cooling occurs depends on the nature of the surface, the thickness and humidity of the atmosphere, and the power of the latter to absorb heat or to permit the radiation to continue rapidly until much of the earth's heat is lost.

Conduction. By this process, heat in one part of a solid, gas, or liquid is passed on from one molecule to the other along its structure. It is in this way that a silver spoon in a very hot liquid will become warm to the touch, even at the handle which is not in the liquid. Two bodies or substances in contact transfer heat from one to the other by conduction, and thus the layer of air in contact with the surface of the earth is not only subject to heating from the earth's radiation but also to direct heating by conduction. The warming of the soil takes place largely by conduction from one soil particle to another. If there were no conduction, only the very thin surface layer would be warmed by the radiation from the sun.

Convection. This is, in many ways, the most important means of heat transference. It applies almost exclusively to gasses and liquids, but since the atmosphere is a gas and the water on the earth a liquid, the climatic effects are most important. The process is relatively simple. It depends on the principle that a hot gas or liquid is lighter than a cold one. Thus, a radiator in a room heats the air near it by conduction and radiation; this air expands and becomes lighter, and the heavier, colder air rushes in to push it upward. This sets up a circulation which carries the heat of the radiator rapidly to all parts of the room.

The earth, warmed by radiation from the sun, heats the atmosphere close to its surface by radiation and conduction, and this heat is distributed through the atmosphere by the convection currents set up.

QUESTIONS FOR DISCUSSION

1. What difference would it make to a manufacturer whether his plant was located in a region with severe winters or one where the temperature seldom went below 32° F.?
2. Does it make any practical difference in economic geography whether heat is transferred by convection, conduction, or radiation?
3. Why does the average person feel uncomfortably chilly in fog, even though the temperature may be considerably above 32° F?
4. Where would you rather engage in the retail clothing business in a region with considerable daily and seasonal change or in a region of little change?

Why Temperatures Vary

Temperatures vary greatly from time to time and place to place. Differences in temperature cannot be explained by any one factor, for each temperature condition is the resultant of many factors which modify the heat received from the sun.

Insolation and Latitude. The heating effect of the sun's rays on the earth is called *insolation* and varies

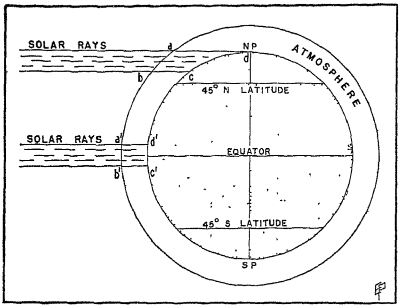


Figure 33 Insolation as affected by latitude

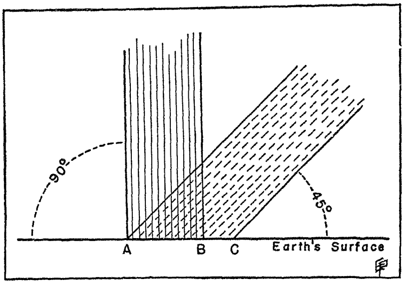


Figure 34. The effect of the angle of the sun's rays on the intensity of insolation. The 90° angle may be taken to represent the sun's rays at the equator at noon on March 21 The 45° angle shows how the sun's rays hit the same place at 3 P.M. the same day.

from place to place according to the angle at which the rays strike the earth and the length of time the sun shines. The effect of the angle at which the rays strike the earth is illustrated in Fig. 33.

If *abcd* and *a′b′c′d′* are two bundles of rays of equal size, *a′b′c′d′* will have the greater heating power. This is due to the fact that *c′d′* is less than *cd*, therefore the heat is more concentrated in the former In addition, *a′b′c′d′* passes through less atmosphere than *abcd*, and its heat is therefore not absorbed by the atmosphere to such a large degree (See also Fig. 34.)

It can be seen that the basic factor in each case is the angle at which the rays approach the earth If it is less than a right angle, its heating power will be less than at the point where the rays are perpendicular. Because the angle decreases away from the equatorial regions, latitude, or the angular distance north or south of the equator, is the principal control of temperature.

Rotation and Revolution. The earth has two motions which have a marked effect on its climate. The first is the *rotation* on its axis which it completes once every twenty-four hours and which causes the regular procession of daylight and darkness. The second is its *revolution* about the sun in its orbit, once every year. This orbit is elliptical and the earth is, therefore, not always at the same distance from the sun. This does not affect the amount of heat received to any important extent. In fact, the time when the earth is nearest the sun is now the winter of the Northern Hemisphere, which is, of course, cooler for that hemisphere than the northern summer when the earth is farthest away from the sun. The explanation of the difference in heat received between one season and another involves another important factor.

The Cause of the Seasons. If the earth's axis were perpendicular to the plane of its orbit, any place on the earth would always receive the sun's rays at the same angle (at the same time of day). There would then be no seasonal variation in insolation and the only seasonal changes in temperature would be the small ones due to differences in the earth's distance from the sun. Actually, however, the axis is tilted 23½° from the vertical which causes the angle of the rays to vary with the earth's position in its orbit. This is shown in Fig. 35. Fig. 36, on a larger scale, indicates in detail how this tilting of the axis affects the angle at which the rays come to significant parts of the earth's surface at June 21 and December 22 (called, respectively, in the Northern Hemisphere the "summer solstice" and the "winter solstice"). This change in the angle of the rays changes the insolation received through the seasons. It also affects the length of the periods of daylight and darkness, except at the equator which is always equally divided by the *circle of illumination* (Fig. 35).

It can be seen from Fig. 36 that on June 21 the sun's rays are perpendicular at 23½° N. (the Tropic of Cancer). The Northern Hemisphere as a whole is getting the most direct rays, so this is the warmer season, or summer, there On December 22, the sun's rays are perpendicular at 23½° S. (the Tropic of Capricorn) and the Southern Hemisphere is receiving the most direct rays, so it is summer there. The Northern Hemisphere is getting the least direct rays, so it is now colder there and winter prevails. Actually, the

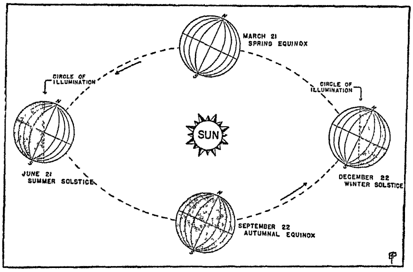


Figure 35 The annual revolution of the earth around the sun.

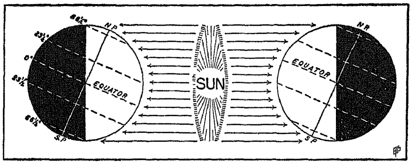


Figure 36 The position of the earth in relation to the sun's insolation at the two solstices. The globe to the left represents the June solstice (the beginning of Northern Hemisphere summer); the globe to the right represents the December solstice (the beginning of Southern Hemisphere summer).

warmest and coolest periods of the year come somewhat later than the solstices as the heating and cooling of the earth lags behind the maximum and minimum insolation. This is so because it takes some time for the effect of the insolation to be felt. Thus, in the middle latitudes of the Northern Hemisphere, July (rather than June) is usually the warmest month and January (rather than December) is usually the coldest.

On Fig 36 it is possible to see the significance of the Arctic and Antarctic circles. They mark the area within which the sun does not shine at all at one solstice and within which it shines for twenty-four hours of the day at the other solstice. In addition, they bound regions at which the sun's rays, when they do come, arrive at a very small angle and, therefore, have little heating power.

From Fig. 36 it also becomes evident that the sun in its *apparent* course northward and southward carries the variations in insolation northward and southward with it. This accounts, in large part, for the seasonal variation in temperature. It can also be seen that this seasonal variation will increase with latitude. The land near the equator always receives rays that are either perpendicular or nearly so, while the farther one travels from the equator the greater is the difference between the angle at the period of maximum insolation and that at the period of minimum insolation.

Length of Day and Temperature. The amount of heat received by a place is also affected by the number of hours during which the sun shines on that place at that season, or the length of the period of daylight. The length of the day at the equator is always the same, for the circle of illumination (Figs. 35 and 36) always cuts the equator in half and there are twelve hours of daylight and twelve hours of darkness (ignoring twilight). But away from the equator, the circle of illumination cuts the parallels exactly in half only at the spring and autumnal equinoxes (*equinox* meaning *equal nights*—see Fig. 35). At any other time of year the parallels away from the equator are unequally divided by the circle of illumination. This can be seen at its highest development in Fig. 36. There it will be seen that a place on the Tropic of Cancer, on June 21, will be in the light a longer proportion of the twenty-four hours necessary to complete a rotation than it will in the darkness. A point on the Arctic Circle will be in the sunlight for the full twenty-four hours. Conversely, on December 22, the place on the Tropic of Cancer will have a longer night than day, therefore it will get less even of the sun's relatively oblique rays and further add to the effect of the smaller angle at which the rays come. A point on or above the Arctic Circle will have a twenty-four-hour night.

Water Bodies and Temperature. In general, water heats and cools much more slowly than the solids of which the land is composed. This is due in part to the fact that, in water, the heat and light of the sun penetrate farther than they do in the solids of the land's surface and the heat which comes to the surface of the body of water is distributed more widely through it. In addition, convection currents are set up which distribute the heat more evenly in the water. A water surface reflects more of the sun's rays that come to it than a land surface. Because the heat is more widely distributed through the water body, it must lose in cooling not only the heat of the surface but that of the depths as well, and cooling of a water body is, therefore, a slow process. On the average, land heats and cools about four or five times as fast as water. From this it can be seen that the temperature of water bodies is very stable and, if the prevailing wind blows from the water to the neighboring

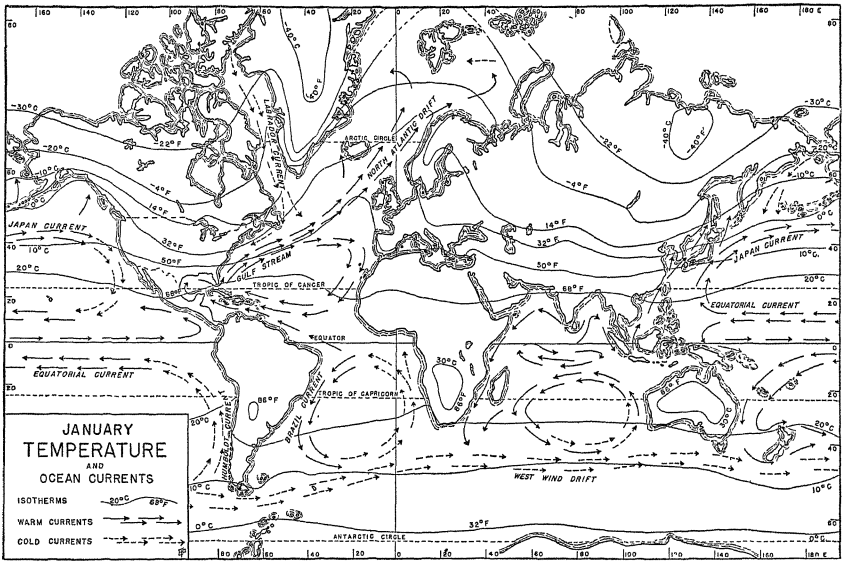


Figure 37 On small scale temperature maps, it is customary to reduce the isotherms to sea-level. To obtain actual average temperatures, approximately 3° F for each 1000 feet above sea-level should be subtracted from the readings on the map.

land, it will help to stabilize the temperature of the land, making it cooler in summer and milder in winter than it would be if insolation were the sole influence on its temperature.

Moisture in the air has a similar stabilizing influence. One of the reasons for the rapid change of temperatures between day and night in desert regions is the lack of any considerable amount of moisture in the air to prevent it from heating and cooling rapidly. In dry climates the sunlight is so exclusively the control of the temperature that there is often a very marked difference between the temperature of air in the sun and that in the shade. In a region of high humidity, the moisture in the air prevents very rapid changes of temperature between day and night and between sunlight and shade.

Wind and Temperature. The effect of wind on the temperature of a place largely depends on the conditions prevailing in the direction from which the wind blows; thus, if it blows from a warmer region it will increase the temperature. In addition, the mere air circulation which accompanies wind tends to cool a place because it tends to increase the rate at which moisture evaporates from the surface and from plants Hence, winds generally lower sensible temperatures. In the tropics, this fact is especially significant.

Ocean Currents and Temperature. Water bodies also affect the distribution of temperature by means of the currents which are set up in them. Currents flowing from low latitudes to higher ones carry the warmth of the lower latitudes with them and currents flowing in the opposite direction carry cold conditions equatorward. The temperatures of these currents affect the shores with which they come in contact and, if the prevailing wind is off the water onto the land, may modify the temperature for considerable distances inland.

Altitude and Temperature. The air is cooler on high mountains or plateaus than at sea-level largely because it is rarer, or "thinner," and thus less able to absorb the heat from the sun and the earth which passes back and forth through it. For each thousand feet of elevation there is usually a drop of 3° F. in the temperature of the air. However, the ground or other

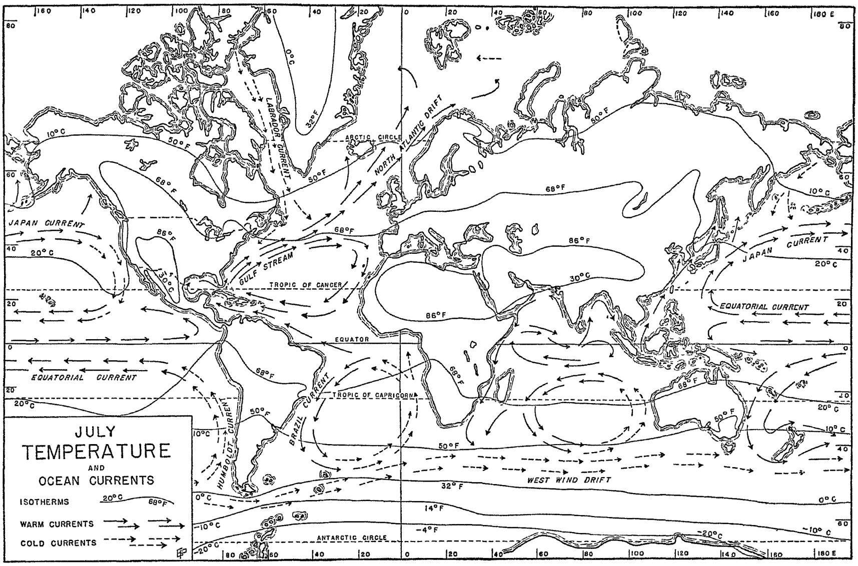


Figure 38.

solid objects exposed to the sun may be warmed to quite high temperatures because the air is too rare to offer much resistance to the passage of the sun's rays. Conversely, there is rapid cooling of the ground at night because of the rapid radiation of the heat acquired during the day. Human beings who are engaged in strenuous activities such as mountain climbing may feel hot in the sun because their bodies are receiving a great deal of unimpeded solar radiation, but passage into the shade or the setting of the sun result in such rapid cooling that there is danger of a chill.

QUESTIONS FOR DISCUSSION

1. Examine the January and July maps of average temperatures (Figs 37 and 38) What evidence is there of the influence of each of the factors described in the preceding section?
2. Why was a Mercator's projection selected for the world temperature maps?
3. Why is the North Pole not the coldest place in winter?
4. Why are the Sahara and Arizona deserts hotter than the equatorial regions during the Northern Hemisphere summer?
5. Consult an almanac and find the length of the 21st day of each month at your latitude.

The Economic Geography of Temperature

Man's adjustments to temperature are so numerous that only a few examples can be given. The temperatures of the soil and the air largely limit the plants man may grow The delicacy of this adjustment may be seen in the case of corn Corn is not raised in important amounts except where the mean summer temperature is between 70° and 80° and there are at least one hundred and forty consecutive days free from frost. Wheat will stand a cooler and shorter summer and requires only ninety days free from frost Wheat also may be grown as a winter crop which is harvested in the late spring or early summer. These facts account in part for the use of wheat as a bread grain in almost every country in the world, and for the wider distribution of wheat than corn.

There are certain temperatures which have a broad general significance. An average annual temperature of 68° marks approximately the poleward limits of the palm tree and, therefore, of tropical plants and tropical conditions in general. *Mean temperatures* be-

tween 50° and 68° are considered temperate. Any region having a mean temperature of 50° or below for four months or more is beyond the limit of the oak tree and, therefore, very largely beyond the limit of the temperate hardwood forest. Any region having a mean temperature of 50°, or lower, for the warmest month is beyond the limit for trees and cereals. This also marks the poleward limit of permanent human occupation except for a few Eskimos and Lapps.

There also seems to be some relation between certain diseases and temperature, although not so much as was once supposed. Infantile paralysis epidemics appear in the United States during the warm weather and practically disappear with the coming of frost. Yellow fever apparently has never become widespread in places where the average temperature does not go above 68° for any considerable time.

An observant person from the northern United States traveling in England would notice, even in summer, many things which would convince him that that country does not have severe winters such as prevail in New England or the Middle West. In the Midlands he would see laborers' cottages with the water supply and sewage pipes laid right on the outside of the wall. If he happened to see water pipes being laid he would be surprised that the trenches were only about eighteen inches deep instead of the four to six feet common in his own country. In the south of England he would see many ornamental plants which were strange to him. Among these are the veronica and fuchsia, commonly used for hedges, and even the palm. All of these might thrive in his summer, but would not survive the winter. New England and Old England have approximately the same *annual average temperature,* but the fluctuation about this average is much greater in New England. The result is a much different landscape in New England, because the winters are much colder. This also results in the necessity for central heating of homes, provision for snow removal, the building of houses to sustain heavy loads of snow on their roofs, and many other adjustments. It probably also accounts, in some small part, for the higher cost of living in New England than in the British Isles.

One of the most important elements in the environment of Russia is its low winter temperatures. A great part of Russia's foreign policy for nearly a century has concerned itself with the attempt to possess ports which are ice-free the year around. The closing of its ports for several months has been of importance in helping to shut that country off from contact with the cultural stream of the modern world. These same cold winters have been, however, Russia's greatest defense. The Russians have a saying that Napoleon's disastrous defeat in his campaign for Moscow was due to Russia's two greatest generals—January and February.

Air Conditioning. By lowering the relative humidity in summer, even very high dry-bulb temperatures may be made to feel only moderately hot. If, in addition, the dry-bulb temperatures are slightly reduced, a very comfortable sensible temperature may be obtained. Air-conditioning in winter usually reverses these operations. In most non-air-conditioned buildings, the dry-bulb temperature is raised without adding to the moisture content of the air, thus decreasing the relative humidity until the air is too dry to be healthy. If moisture be added to the air, a relatively low dry-bulb temperature will seem comfortable; thus fuel may be saved.

The control of temperatures in buildings may make it possible to improve greatly the health, comfort, and efficiency of peoples in those parts of the world which experience unpleasant extremes of temperature. The cost of air-conditioning and the necessity of carrying on many occupations outdoors are important limiting factors. Another problem is the difficulty the human body has in adjusting itself to great and sudden changes in temperatures. Thus it is inadvisable to make too great a difference between outdoor and indoor temperatures, especially in summer when people do not usually vary the amount of clothing to meet indoor and outdoor conditions.

QUESTIONS FOR DISCUSSION

Although a complete analysis of temperature conditions cannot be made until the material on winds, storms, and ocean currents in the following chapters has been studied, enough has already been revealed to make an analysis of Figs. 37 and 38 profitable.

1. What is the general direction of the trend of the isotherms on these maps? In which season do they depart most radically from this general direction? How can you account for these facts?
2. Why do the isotherms bend sharply when passing from the oceans to the land masses? Which way do they bend in the Northern Hemisphere in January? in July? Why? Make a similar analysis for the Southern Hemisphere.
3. Where is the coldest area in January? in July? Why? Where is the warmest area in January? in July? Why?
4. Winds between 35° and 60°, both north and south, are generally from the west. Does this fact help to explain the behavior of the isotherms on these maps?

CHAPTER 8

MOISTURE

LIFE, as it is known on this planet, is impossible without water. In fact, life apparently developed first in the form of primitive organisms in the sea, and it was only recently, as the history of life is measured, that organisms have been developed which can live in any but marine conditions. Some of these evolved forms—such as the cacti or the reptiles of the desert—can live with surprisingly little moisture, but there are apparently none which can survive under conditions of absolute aridity.

To man, the amount of moisture available is an important feature of his environment This is often hidden, because most people of the world live in regions where the moisture supply is relatively adequate. If it were not normally sufficient, no considerable number of people could inhabit the region. Perhaps this "begging of the question" of man's adjustment to moisture supply is one reason for the common statement among the Classical Economists in England (where rainfall is abundant) that water is an example of a "free economic good." It is "free" only in regions having enough for all purposes and all peoples without cost. In a region such as northern Africa, or Arabia, where every drop is laboriously drawn from deep wells, where the sound of the crude pumps is never stilled, man is decidedly conscious that he is living where water is not "free."

Even within the regions of "abundant" water, the varying requirements of the different crops, animals, and occupations cause man to carry on one activity in a yearly average rainfall of thirty inches and another in a yearly average of sixty inches. There is even such a thing as too much rainfall. In the wet tropics where heavy rainfall is combined with high temperatures, the growth of weeds and other natural enemies is almost too much for man. The extensive swamps of the tundra and the subarctic forests impede transportation and provide breeding places for insect pests which, in the summer, make life almost unbearable. Even the British Isles have, in some parts, so much moisture that man is decidedly limited in his choice of ways to make a living.

The Water Vapor of the Air

The water which comes to the land in the form of rain, snow, fog, dew, or hail comes out of the air. One of the most important natural processes is the cycle of evaporation of moisture from the parent seas, its absorption into the air in the form of water vapor, its transportation over the land by the winds, its condensation and precipitation onto the land, and its subsequent return to the air through evaporation or to the seas through streams. If any element of the cycle were missing there would be no moisture on the land. Because the variations in the amount of moisture at any point on the land depend most immediately on the condition of the air over it and the water vapor this air contains, some considerable attention must be given to this aspect of the cycle.

Absolute and Relative Humidity. The absolute amount of moisture in a given volume of air is called the *absolute humidity* and is usually measured in a unit of weight such as grams or grains But the ability of the air to hold moisture varies with the temperature of the air, for example, a cubic foot of air at 86° F. can hold about twice as much moisture as a cubic foot of air at 68° F. The most important fact about the moisture of the air is not so much the quantity which is present, but the ability of the air to take up more moisture or to release that which it has. Therefore, climatically, the *relative humidity* is most important. Relative humidity is the relation between the amount of water vapor present and the amount the air can hold *at that temperature.* It is always expressed as a percentage.

The importance of relative humidity may be illustrated in a very simple way. Let it be assumed that there are 5 grains of water per cubic foot in the air at a given time. At 80° F., air is capable, under normal pressures, of holding 11 grains. Thus, the relative humidity is $\frac{5}{11}$ or about 45 per cent. This would be dry air and would cause rapid evaporation from bodies of water and plants and animals with which it came in contact. If the temperature of this air were reduced to 60° F. without any change in the absolute

humidity, the air would be saturated because, at this temperature, air can hold just 5 grains of water. The relative humidity would be 100 per cent, and the air would be very moist, would feel damp, and would not permit any evaporation from bodies with which it came in contact. A slight further reduction of temperature would result in the air losing some of its moisture in rain, snow, dew, or fog as it is now incapable of holding the 5 grains present.

Technically, the process is as follows:

1. Reduction of the temperature of the air (cooling) causes increase in the relative humidity.
2. If this cooling goes far enough, the air reaches a temperature at which it is holding all the moisture it possibly can. This condition is known as *saturation,* and the *relative humidity is 100 per cent.* This is also the *dew point,* as here the water vapor in the air begins to condense.
3. Condensation takes place; that is, tiny droplets are formed, giving rise to clouds or fog
4. If further slight cooling takes place, or the condensation is long continued, tiny droplets merge into larger ones about nuclei of dust particles and there is precipitation—in the form of rain if the temperature at which precipitation occurs is above 32° F, and in the form of snow if the temperature is below 32° F.

The general rule is, *to cause condensation or precipitation, air must be cooled to the point where it can no longer hold all of the water vapor present.* This is one of the most important general concepts and will be used constantly, in the pages to follow, to explain rainfall.

An extreme drop in temperature is seldom needed to bring about saturation, since a drop of about 18° F. is sufficient to reduce by approximately one-half the amount of moisture which the air can carry. Only in the very driest portions of the world is the relative humidity out of doors commonly less than 50 per cent. The average for the eastern part of the United States is about 70 to 75 per cent, and the average for even the drier parts is but 10 to 20 per cent lower, although extreme conditions give relative humidities of as low as 20 per cent. Air with a relative humidity of less than about 65 per cent is usually considered dry.

Dew, Frost, Fog, and Clouds. The condensation which results from the cooling of the air to the saturation point, or dew point, occurs in several forms. After sundown, the material of the earth's surface and the plants which grow upon it proceed to lose the sun heat very rapidly. If this cooling proceeds far enough, the soil and the plants become cool enough to lower the temperature of the air in immediate contact with them to the saturation point, and thus a film of moisture is deposited. This is *dew.* If the temperature at which condensation of this thin film occurs is below 32° F., the moisture freezes and becomes *frost.* Frost is more apt to occur on still nights than windy ones, because under the latter conditions the air being cooled is constantly being replaced with air of a higher temperature. This, taken in conjunction with the fact that air on slopes is usually in motion, helps to explain the *air drainage* discussed on page 47.

When a mass of air is cooled to the point of condensation and the tiny droplets remain in suspension in the air, the phenomenon is called *fog* if it is in contact with the earth's surface and *cloud* if it occurs at higher altitudes.

Fog is of considerable economic importance and most of its influences are harmful It decreases visibility and thus slows down vehicles on land, sea, and in the air. While many instruments have been developed to facilitate travel through fog, many accidents are still caused by foggy weather. Marine insurance rates in regions susceptible to frequent fogs are still high. In cities, fog not only ties up traffic, but causes increased expense because it necessitates greater use of artificial light. There are, however, some advantages of fog. It prevents extreme changes in temperature and, in some arid places—such as the higher parts of the coastal desert of southern Peru—may furnish the only moisture to an otherwise dry region.

There are many relations between cloudiness and man's comfort and activities entirely apart from the relation between cloudiness and rainfall. The most obvious is that cloudiness cuts down the amount of sunshine received at the earth's surface. This has a direct bearing on health and mental attitudes, on evaporation and temperature A long succession of dark, cloudy days tends to be depressing. Cloudiness also makes winter days seem colder through lack of sunshine, although it actually prevents too rapid drops in temperature. Cloudy regions have low rates of evaporation with a consequent higher effectiveness of the rainfall.

Clouds (Plate VI) vary in appearance according to the conditions under which they are formed. They range from the "puffs of cotton" of fair days to the more or less continuous gray canopy of days when a steady drizzle goes on for hours.[1]

[1] Cloud forms are so important to the meteorologist, the aviator, the artist, and the photographer that there is a necessity for a uniform classification The International Meteorological Committee has therefore published an *International Atlas of Clouds and of States of the Sky* (Office National Météorologique, Paris-Abridged Edition, 1930, Complete Edition, 1932). See analysis of Plate VI, page 66.

To the aviator, clouds are of especial interest. They not only affect visibility for flying, photographing, and landing, but they serve as indications of weather at different levels. There is almost constant interchange of weather information, much of it having to do with clouds, between airport weather stations and planes in flight. The height of the "ceiling" (the bottom of any clouds below 9750 feet and covering more than half the sky) and the altitude, thickness, and continuity of other cloud layers are information of vital importance. The ceiling is said to be "zero" when fog, heavy rain, or driving snow limit visibility on the ground to less than one-fifth of a mile.

Precipitation. Rain, snow, and hail are grouped together under the term *precipitation*. The causes of the first two have already been discussed. *Hail* occurs usually in summer when strong ascending convection currents during a shower carry raindrops upward again, after they start to fall, to such heights that they freeze and finally fall as hail.

Precipitation is measured in terms of the depth in inches (millimeters in countries having the metric system) of water which would stand on a flat surface if all of it were caught. The instrument used is a simple cylinder into which the rain is allowed to fall, and its depth is then measured according to the scale used. Snowfall is measured in terms of its rainfall equivalent. The usual rule of conversion assumes that ten inches of snow is equivalent to one inch of rain.

Actually, there is no really satisfactory method of measuring snowfall under all conditions and the economic significance of snow is much different from that of an equal amount of water falling as rain. With snow, the runoff is less immediate. Sometimes its available moisture supply is held in check until the approach of the warmer season releases it. In this way it supplies water to streams during the warmer months for use in irrigation and navigation, although the actual fall took place in the colder season. Ten inches of snow have an entirely different relation to all forms of transportation than a fall of one inch of rain, especially if the snow is accompanied by wind which may drift it to considerable depths. Because the precipitation figures usually available do not differentiate between snow and rain, they may conceal very important environmental differences between two regions if one has a considerable amount of snow and the other none, even if both have the same average annual precipitation.

Hail occurs so infrequently and the hailstones survive such a short time that hail is not measured except as to its duration and damage and the amount of water which it contributes, after melting, to the rain gauge. The damage done by hail is increased because it is almost entirely associated with the warmer season when crops are growing. The damage is greatest to plants, such as tobacco or lettuce, the leaves of which are their commercial products, or to fruits which may be bruised by the hailstones or beaten from the trees before they are ripe. After plant injuries, the next largest single item to be damaged by hail is the glass of hothouses. An obvious adjustment to this form of danger is hail insurance which is quite common in tobacco regions and areas having large numbers of hothouses. Fortunately, hailstorms are relatively infrequent, most parts of the United States averaging less than three a year.

QUESTIONS FOR DISCUSSION

1. Can you illustrate the process by which precipitation occurs by using a steaming teakettle and a cold dish?
2. How may the nature and amount of precipitation influence a railroad company?
3. Consult the weather reports for several days. How much rain falls during an average rainy day? What is the usual relative humidity on clear days? on rainy days?

Conditions Causing Precipitation

It has already been pointed out that precipitation results from the cooling of air to the dew point. While this is the general rule and must be kept constantly in mind, a further list of factors must be studied because *they give rise to the cooling which causes precipitation.*

Convection. When air rises, it expands because there is less and less weight of air above to press down upon it. In the process of expanding it gives up heat, thus it becomes cooler and its ability to hold moisture decreases. If the cooling is sufficient, condensation occurs in the form of clouds and, if carried still further, precipitation occurs. Conversely, air moving downward toward the earth's surface is compressed by the increasing weight of air above it. Compressing air raises its temperature and its ability to hold moisture is thus increased.

The effect of compression and expansion on the temperature of air is within the experience of everyone. For example, air under high pressure in an air hose such as is used to inflate automobile tires is noticeably warm at the nozzle, where its pressure is still high, but is felt as a cooling breeze a few feet away where it has expanded nearly to the pressure of the outside air.

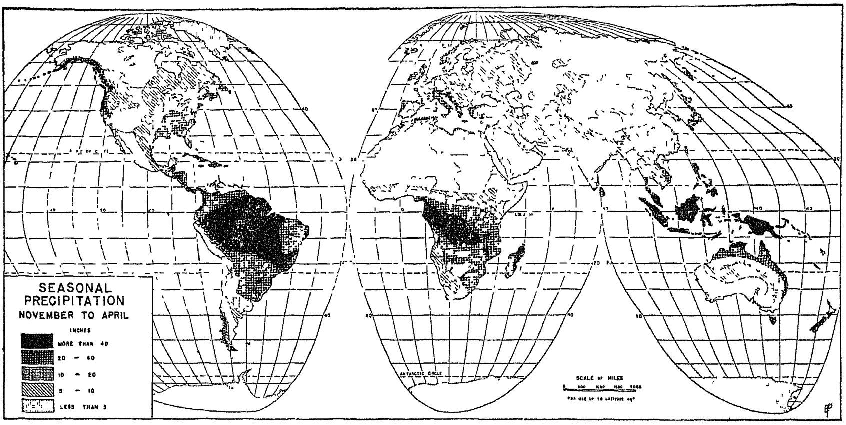


Figure 40. (Goode's Homolosine projection, by permission of the University of Chicago Press)

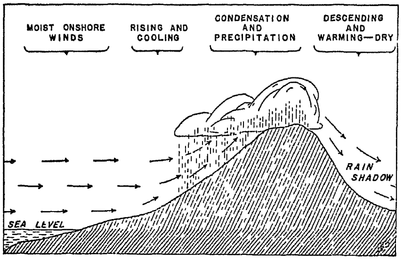


Figure 39. The relation between relief and rainfall.

Topography. If the wind blows against a mountain range and is forced up, precipitation may occur on the *windward side* for the same reasons that it occurs in a rising column of air due to convection. The *leeward side* will tend to be dry under these conditions because the wind blowing over the mountain descends, is compressed and therefore warmed, and its ability to hold moisture is thus increased. The dry areas to the leeward of mountain ranges in regions of steady prevailing winds are said to be in the *rain shadow* of the mountain range (Fig. 39).

Latitude. In general, winds blowing toward the poles are blowing from warmer areas to cooler areas. While these winds are warming the areas into which they blow, the air in the winds is being cooled by contact with the relatively cool land or water beneath it. The cooling of this air may be sufficient to cause a fog or even precipitation. Winds blowing equatorward have just the opposite effect and are usually drying winds.

Differences in Nature of Surface. Air blowing from one type of surface to another may be heated or cooled by the unequal heating of different surface materials, even in the same latitude. Thus, in winter, wind blowing from sea to land would be cooled because the land has lost the summer heat much more rapidly than the sea. Under these conditions, precipitation may occur. In the summer, the land is warmer than the sea and precipitation is unlikely with an onshore wind. Precipitation may occur over the sea if it is cooler than the land and there is a seaward wind.

Changes in Air Pressure. When the pressure of the air changes, the temperature of the air also changes. The expansion of the air usually causes cooling and consequently may cause rain. Compression of the air increases the air's temperature and lessens the chances of rain. Air pressure and the winds which are caused by differences in air pressure will be discussed in Chapters 10 and 11.

Precipitation and the Total Environment. The presence of one factor favorable to precipitation is no assurance that precipitation will occur; the entire combination of factors must be favorable. The air must contain enough moisture so that a small amount

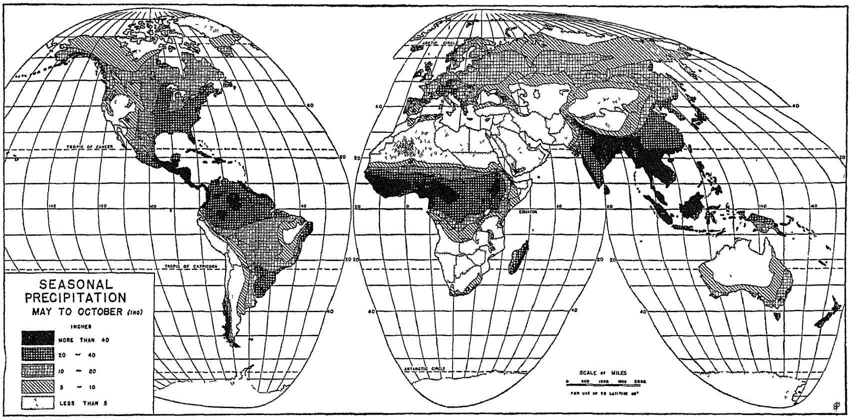


Figure 41. (Goode's Homolosine projection, by permission of the University of Chicago Press)

of cooling will lower the temperature to the dew point; the cooling must be adequate, the conditions between the clouds and the earth's surface must be such that the moisture does not evaporate into the lower air.

Sometimes one favorable factor is powerful enough to overcome a number of unfavorable factors; thus the combination may favor precipitation even though the majority of the factors in the combination oppose it. For example, ordinarily a wind blowing from north to south (in the Northern Hemisphere) will not result in rain. However, the presence of a high mountain range may force this north wind to ascend so that rain results from the cooling of the ascending air. In considering practical problems of the weather, as well as in other geographical problems, the total environment rather than any one factor should always be considered.

QUESTIONS FOR DISCUSSION

1. On the rainfall maps (pages 64, 65, and inside rear cover), find as many examples as possible of rainfall caused by topography. Likewise find several important rain shadows.
2. Keep a record of the weather during the next month. Note the temperatures each day, the amount and kind of clouds, the direction of the wind, and the amount and kind of precipitation. As you study the following chapters, attempt to work out an explanation of the weather changes you have recorded.
3. From your own observations, have you noticed any relationships between the kind and amount of clouds and rainfall conditions?
4. Why does fog in mountainous regions settle at night and lift in the morning?

The Disposition of Precipitation

Most of the moisture man uses is obtained only indirectly from precipitation. It therefore becomes important to consider what happens to precipitation after it falls. There are three important ways in which precipitation disappears: it *evaporates,* it *runs off* the surface and forms drainage systems, or it sinks into the ground and becomes *ground water.*

Evaporation. The moisture which evaporates goes back into the atmosphere and adds to the humidity, thus increasing the chances of further precipitation Water bodies, the ground, plants, animals, in fact anything which has moisture on its surface or near it, is subject to drying by evaporation.

Runoff. A large proportion of the precipitation is taken away from the surface on which it falls by *runoff.* During a rain, water runs as a thin sheet down broad slopes and concentrates in gulleys to flow to the permanent streams. The soil damage, through erosion, which is done by gulleys is spectacular, but even the washing of the finer particles from the soil by the thin sheets of water flowing over the fields is tremendously destructive.

Not all of the runoff flows at once toward the sea, because lakes and glaciers, acting as reservoirs, release but slowly the moisture they impound. Lakes are formed wherever some barrier such as a glacial moraine or a rock ledge prevents all of the water of a stream from flowing toward the sea. Conse-

quently, the water spreads out over the land back of this natural dam and forms a lake, or, if the dam is not very high, a swamp Such lakes are very important for navigation, fishing, scenic beauty, and for their moderating influence on the climate. Glaciers on mountains are also important as reservoirs. They store up moisture from the winter snows and gradually release it during the spring and summer when it is needed for irrigation and to maintain the normal level of the rivers. In lands of summer drought, snow-covered mountains, where present, have always played an important part in the life of the people.

The oceans are the ultimate destination of most of the runoff; they are the great storehouses of the earth's moisture. From their surfaces evaporates most of the water which forms the clouds, hence the amount of precipitation often varies with distance from the sea.

Ground Water. Another important portion of the precipitation soaks into the ground and becomes *ground water*. Some of it clings to the soil particles and becomes the water supply for the root systems of plants. A considerable quantity sinks further into the ground until either the nature of the rock structure or the presence of an already saturated layer prevents deeper penetration. The top of such a saturated zone is called the *water table*. The water table is often cut into by valleys. This offers escape to the surface for the ground water and a zone of springs results. The slow percolation of ground water through sub-surface materials releases it slowly and steadily to springs and streams. Ground water may travel great distances underground before finding a depression in the surface deep enough to intersect the water table. On the Pampas of Argentina and in the so-called Artesian Basin of Australia, precipitation on mountains hundreds of miles away is the source of ground water which makes it possible, by means of wells and pumps, to supply water to sheep and cattle in regions with low rainfall and almost no permanent surface water.

QUESTIONS FOR DISCUSSION

1. In rural districts near your school, how important is each method by which precipitation disappears?
2. On the rainfall maps, check the truth of the statement that "the amount of precipitation often varies with distance from the sea."

ANALYSIS OF PLATE VI: CLOUDS

VI A. Cumulus clouds result from vertically-ascending air currents caused by convection Descending cooler currents cause gaps between the clouds The flat bases often visible on these clouds mark the level where condensation begins. These clouds can be identified by their "puff of cotton," cauliflower, and thunderhead shapes. In the sunlight they are white but if very thick or in the shade may appear gray or black.

VI B. This type of cumulus cloud is usually associated with heavy rains, especially thundershowers. It is thick and dark and its base often has a broken layer of stratus clouds. The upper parts of the cloud mass are often being transformed into cirrus clouds

VI C. Cumulus and cumulonimbus clouds are usually from one-half to two miles above the surface of the earth. When cumulus clouds occur at heights of from one-and-a-half to three miles above the surface, they are called altocumulus Such clouds are not usually rain-producers.

VI D Cirrus clouds are usually fair weather clouds. They occur most commonly at heights of from five to nine miles Their temperatures are so low that they are composed of minute ice crystals.

VI E Stratus clouds are low, fairly uniform sheets of cloud. When they occur at the surface, they form a fog. They are most common in winter when they shut out most of the sun's rays and cause dark, depressing days. Such cloud masses are caused by the contact of an air mass with land, water, or another air mass having a lower temperature. Rains, often lasting for many hours or even all day, result from the formation of stratus clouds followed by further cooling.

VI F Tornadoes occur along an abrupt cold front of a well-developed cyclone. A funnel-shaped cloud, composed of droplets of water, forms at the center of the storm. It is believed that the wind velocities near the center reach 200 to 300 miles per hour and that the updraft at the center occurs at a rate of over 100 miles per hour In the United States the tornado itself usually advances from southwest to northeast at a rate of 20 to 40 miles per hour. These figures are necessarily estimates since all meteorological instruments near a tornado are usually destroyed by its passage.

Note on other clouds: There is no sharp division between the various types of clouds and numerous transition forms are recognized Most of these forms are named by combining the names of two forms, for example: cirrostratus, cirrocumulus, stratocumulus, nimbostratus, or by prefixing *alto* (high) or *fracto* (broken) to the name of the principal type, for example, altocumulus, altostratus, fractostratus.

CHAPTER 9

MAN AND MOISTURE

IMPORTANT lines which determine the habitability of the earth are those which mark the limits of land having too little, too much, and a satisfactory amount of moisture. As will be shown later, these limits cannot be expressed exactly in terms of inches of precipitation because a given amount may have one meaning in one place and a markedly different meaning in another. Nevertheless there are several precipitation figures which, because of their broad general significance, should be learned for future use. In discussing these figures, frequent reference should be made to maps in an atlas showing density of population and annual rainfall. The significant precipitation figures are as follows:

1. *Ten inches of average annual rainfall* Places having this amount of rainfall, or less, are usually classed as "arid," or desert. Ten inches of rainfall are insufficient for agriculture and usually insufficient for good pasture. In lands with so little rainfall, even drinking water is scarce. Where concentrations of population occur under these rainfall conditions, usually water is obtained from rivers arising in more humid areas. (Compare arid areas on a rainfall map with the population density map)
2. *Twenty inches of annual average rainfall.* This is a very important figure because most of the world's population lives in regions having greater rainfall than twenty inches. It is usually considered as marking the boundary between the lands with too little rainfall and the lands with enough In most regions, less rainfall than this involves special methods of water conservation or irrigation, and special crops. Ten to twenty inches are usually taken to represent "semiarid" conditions (Note the correspondence between the twenty-inch rainfall line and the population density in Eurasia, Australia, and North America, especially.)
3. *Twenty to eighty inches of average annual rainfall.* Within this range live most of the world's people, and here also are found the rainfall requirements of most of the world's important food, raw material, and fodder crops (Compare the maps of corn production, Fig. 111; wheat production, Fig. 98; population density; and rainfall)
4. *Eighty inches of annual average rainfall* This figure not only marks the upward limit of the rainfall zone containing most of the world's population, but rainfall greater than this is, under most conditions, considered excessive. If it is combined with low average temperature, the low rate of evaporation brings about excessive moisture If it is combined with high temperatures, plant growth is rapid and difficult to control. (Note how few areas there are with dense population in regions of over eighty inches average annual rainfall.)

The Effectiveness of Moisture

The effectiveness of rainfall is measured in terms of the amount of moisture that is available to plants, animals, and human beings and not in terms of annual average inches of water in a rain gauge. In addition to the figures given above, several other factors must always be considered in analyzing the biological and economic significance of precipitation.

The Seasonal Distribution of the Rainfall. This is of the utmost importance. Many regions having at least twenty inches of average annual rainfall suffer from dryness because most or all of it falls in the colder season when it is not available to annual crops. On the other hand, the prairie provinces of Canada have less than twenty inches, but are important wheat-growing regions, in part because most of this rain falls in summer and in part because of the low rate of evaporation which makes what does fall more largely available for plants.

The Rate of Evaporation depends on the *temperature* and the *wind.* The prairie provinces of Canada mentioned above have a low rate of evaporation because they are so far north that their average temperature is low. The desert and semiarid regions of the world are due to a combination of low rainfall and a high rate of evaporation. The moderate rainfall and low rate of evaporation combine to make a large part of the British Isles too wet for most crops and helps to explain the prevalence of meadow and pasturage there. Only in the southeast of England where the rainfall is between twenty-five and thirty inches is the moisture low enough for most crops. Yet, C. E. P. Brooks, in his classic *Climate through the Ages,* says that "a hot country with the rainfall of southeastern England would be dry!" At a mean annual temperature of 86°, a desert might prevail where the rainfall was as much as forty-eight inches.

Variability. Figures for average annual rainfall often are quite misleading. No annual crop is raised on an average amount of rainfall—hence the rainfall which actually comes during the season of growth is of most significance. A region may have an average

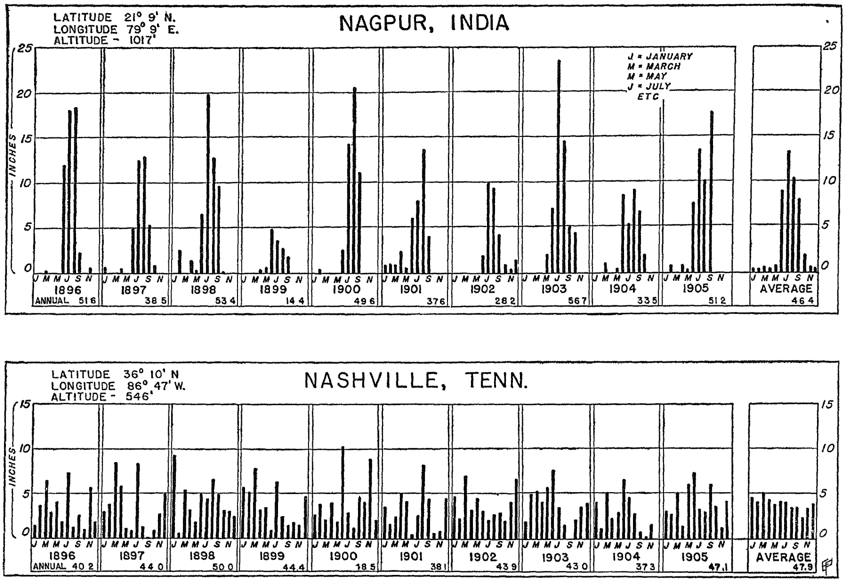


Figure 42. Seasonal and annual rainfall variations at contrasting stations.

precipitation which is apparently adequate for a crop and still not be able to grow that crop in any given year because, for that year, the rainfall was below the average. Note on Fig. 42 that the rainfall conditions for Nashville and Nagpur are quite different, although the annual averages are almost the same. Note also the differences in the seasonal distribution and amount of the rainfall from year to year. Fig. 43 shows the degree of variability of rainfall in the various parts of the world. It is striking that the regions with the less satisfactory total amounts of rainfall are also those having the least dependable rainfall.

The Nature of the Soil and the Underlying Rock. There is a reciprocal relationship here, as the climate affects the nature of the soil, and, at the same time, the nature of the underlying rock from which the soil is formed may seriously affect the effective temperature and rainfall. A soil such as a sand or sandy loam permits rapid circulation of air and water. Thus rainfall soaks into such a soil quite rapidly, but it also dries out rapidly. A clay, on the other hand, is so tightly packed that it is slow to absorb moisture and slow to give it up. Thus a short shower may be of considerable benefit to plants on a sandy loam, but of hardly any benefit to those on a clay.

An underlying porous rock—such as limestone—may have striking results on vegetation and surface water. The mountains along the eastern shores of the Adriatic Sea receive between forty and sixty inches of rainfall, but are usually dry because the cracked and seamed limestone allows the water to drain into underground streams as fast as it falls. Such a condition is known as *Karst* and there are usually few, if any, surface streams. Similar conditions prevail in the Aran Islands off the west coast of Ireland. There, three days of sunshine in summer dries up the limestone roads until everything that moves on them sets up a cloud of fine gray dust. At such times water must be carried to cattle in the pastures, although the rainfall averages about forty-eight inches a year and is well distributed seasonally.

The Form in Which Precipitation Occurs. A part of the cause for the high effectiveness of the

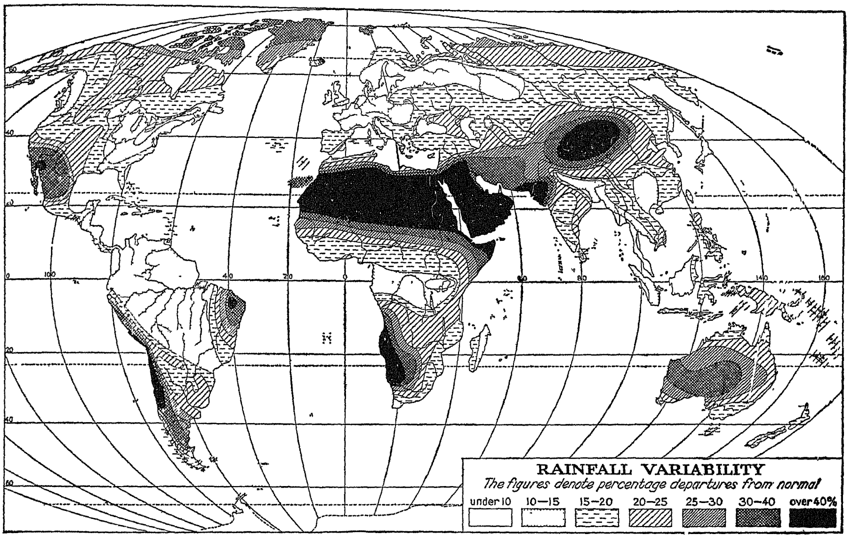


Figure 43. (Reproduced from Isaiah Bowman, *The Pioneer Fringe,* American Geographical Society, New York, 1931)

rainfall in the British Isles is found in the fact that it is often in the form of a mist or very gentle drizzle. Such a rain soaks in and does not run rapidly off the surface. A country of this type usually has a mature, gently rolling topography because its streams are of even flow and have numerous tributaries.

In arid regions, deep canyons and "washes"—dry most of the time—are due to the tendency of the infrequent rains to fall as "cloudbursts," causing rapid runoff and erosion, soon leaving the land parched and dry. In contrast with conditions in the British Isles, such rainfall does not soak in to form a reserve of ground water. There are therefore few permanent springs to maintain the flow of streams throughout the year.

If a considerable proportion of a region's annual precipitation is snow, that fact is significant. Snow falls in the season when it can do the least possible immediate good to plants. It may act as a handicap to transportation. If it melts rapidly, it produces floods, though if the snow-cover melts slowly, the water sinks into the ground and furnishes a supply of subsurface moisture which may last well into the summer. Where snow accumulates as permanent glaciers, the melting fronts may provide to areas hundreds of miles away, water for irrigation, power, or domestic supply.

QUESTIONS FOR DISCUSSION

1. Regions A, B, and C each have an annual average precipitation of thirty inches. Region A has satisfactory moisture conditions for crops, B is too wet, C is too dry. In what ways may this be explained?
2. Is twenty inches of winter rainfall more valuable as a source of drinking water than twenty inches of summer rainfall?
3. Does the underground structure of an area greatly influence water requirements of a plant?

Domestic Water Supply

Men in any very advanced stage of civilization need large quantities of water for drinking, cooking, and washing, and must, therefore, locate where a considerable supply is available. Even in the moister parts of the world, local variations in the availability of domestic water have had a marked effect on the distribution of houses in rural districts. This relationship grows increasingly stronger in drier regions, until in the deserts only the oases have permanent population.

In crowded agricultural districts, the pollution of the readily available ground and surface water by wastes from houses and barns often renders local water dangerous to drink. This has undoubtedly had

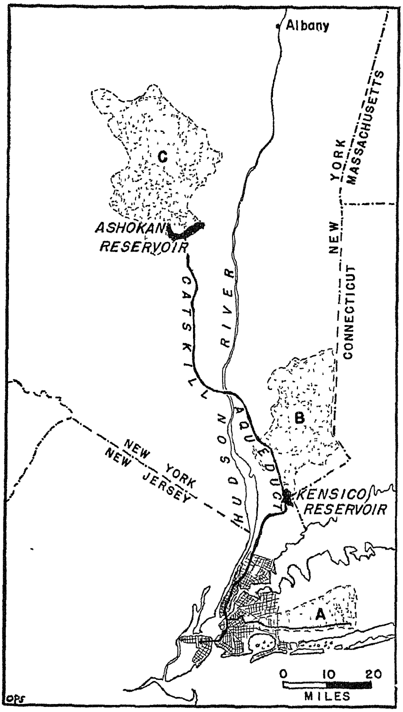


Figure 44. The stippled areas represent the present sources of New York City's water supply. A provides artesian well water, B is the Croton watershed; C includes a large part of the water resources of the Catskill Mountains The water from these watersheds has recently proved inadequate and new areas to the southwest of the Ashokan Reservoir are being tapped.

some effect in determining what will be the common beverage of a country. In lowland China it is almost always tea, because of the purifying effect of boiling water in its preparation. In the Mediterranean countries and France, wine is the common beverage, partly because the dense rural population lacks the funds necessary to support expensive community water works and sewage disposal.

There are some communities in arid regions where there is absolutely no local water supply. These communities always have some outstanding resource which allows them to pay a high price to have water brought from a distance. Examples are the mining towns in the Nevada deserts and the hotels on the edge of the Grand Canyon which import their water in tank cars from distant mountain streams. Only the gold and silver deposits in Nevada and the scenic attractions of the Grand Canyon make it worth while to use such costly water.

City Water Supply. The provision of water for the world's large urban areas has given rise to fields of engineering and chemistry which are specialties in themselves. London must secure its water supply from the densely populated Thames Valley and must use the river, also, as a means of disposing of its sewage. This has led to chemical treatment of the water which renders it perfectly safe, but makes it almost a "chemical," rather than a "natural" product. Most of the cities on the Great Lakes in North America draw their water supply from the nearest lake and at the same time discharge their sewage into it. One of the most important problems connected with the rapid growth of Chicago was the provision of a safe water supply and the disposal of the tremendous sewage. The "cribs" which carried the water intakes had to be pushed farther and farther into Lake Michigan as the water near shore became more and more polluted. Finally, Chicago dug a canal which reversed the flow of the Chicago River and used that stream to flush its sewage down the Illinois River toward the Mississippi, thus decreasing the danger of polluting the waters of the lake. Some idea of the quantities of water used in a day may be derived from the fact that the Union Stock Yards, alone, use an amount of water which would be sufficient for the needs of a city of 1,250,000 people. Most of this becomes sewage immediately after use and must be disposed of in a safe manner.

Some cities—such as New York, San Francisco, and Denver—are fortunate in having mountainous areas near at hand which may serve as watersheds for the collection and storage of a supply, which is transported in great pipes or aqueducts to the urban centers. The problem for cities located in dry areas, on plains, or in river deltas is much more difficult.

Sewage Disposal. The problem of city water supply is bound up very closely with the problem of sewage disposal. It is not only necessary to have large quantities of water to flush and dilute the sewage, but to avoid the pollution of water supplies of other communities. In Europe, where population density is great over wider districts than in the United States, mechanical and chemical sewage disposal plants are much more common. In this way, the solids are settled

out of the sewage and the water is purified. This results in an economy of water, a saving of vitally necessary fertilizers, and the avoidance of the dangers of pollution of streams into which the liquids are discharged. Growing urban populations may make the almost universal adoption of such methods a necessity.

Industrial Uses of Water. The importance of water as an industrial resource is much greater than is commonly realized A large steam plant uses, on the average, four hundred to five hundred tons of water for every ton of coal and must, therefore, be assured of a very large supply of water at little cost. This is one of the reasons why large carboelectric plants are usually located along streams, even where the coal supply is not brought to them by water transport. The generation of hydroelectric power (to be discussed more fully in Chapter 26) requires huge quantities of water, which is not, however, injured for other uses.

Rayon manufacturing, wool scouring, and paper making are also tremendous users of water In all of these cases, it is not only a question of the amount of water available, but also its quality. The water must be free of silt and, for most purposes, be "soft"—that is, free of any large quantities of calcium or magnesium. The importance of this latter factor can be illustrated by the early distribution of wool manufacturing in England. The large areas of limestone soil were avoided because of the "hardness" of the water and areas underlain largely by granite or other "acid" rocks were favored. Today, tremendous sums are spent to "soften" water, chemically, in regions where other advantages of location outweigh the cost of such practices.

Irrigation—The Civilizer

The great civilizations of antiquity in the Mediterranean and the Near East were in arid regions where the production of food was made possible by well and river waters which might be artificially applied to the land. Then, as now, water was usually carried by ditches from the source of supply to the fields. In some cases smaller, often temporary, ditches were used to carry the water between the rows of plants or trees, or the whole field was flooded periodically to allow the soil to soak up moisture. The antiquity of irrigation may be judged from the fact that the Hebrew writers believed the Garden of Eden to have been irrigated, as in the passage: "And the Lord God planted a garden eastward in Eden. . . . And a river went out of Eden to water the garden." [1] The Hebrew scriptures as well as the literature of other Near Eastern peoples are full of allusions to irrigation.

Irrigation is supposed to have developed first in Egypt, although it may have originated spontaneously in a number of widely separated regions. Certain it is that Egypt and Mesopotamia (present-day Iraq) developed irrigation to its highest state. Egypt is still the outstanding example of a successfully irrigated region.

There are four principal reasons for the rise of dominant civilizations in irrigated regions:

1. Because they were dry, there was no cover of forest to be removed with the crude tools available in antiquity.
2. Because they were dry, the soils were unleached and yielded abundantly when irrigated. In river valleys, the overflow of the river also enriched the land with the silt it deposited.
3. The advantages of peace, justice, and a strong government were more obvious to a people living so close together and being so vitally dependent on the fair distribution of the life-giving waters.
4. The presence of a large, concentrated population, all faced by somewhat similar problems, encouraged the development of many sciences. For example, in Egypt, the annual necessity of laying out and subdividing irrigated fields encouraged the development of geometry.

Irrigation spread from its earliest centers of development throughout the Ancient World, wherever water for irrigation was available and the need for it was present.[2] In some places, such as Egypt, no crop was possible without it, for Egypt is almost rainless Elsewhere, as in parts of Greece, Italy, and Spain, it became the common practice to store the water of the rainy winter for use in the dry summer. Many different sources of water and irrigation practices developed. Rivers, wells, springs, and lakes furnished water, either by gravity directly to the fields or by crude, but ingenious, pumps. Actually, there is little that is fundamental in modern irrigation that was not discovered centuries ago in the Old World. Only the materials and size of our greatest irrigation projects are new.

Problems of Modern Irrigation. The existing large areas of land with insufficient rainfall and the tremendous successes scored by some irrigation projects and the complete failure of others lead inevitably to an examination of the factors which limit or encourage such developments.

[1] Genesis II, parts of verses 8 and 10.

[2] Irrigation was also used in early times in Peru, Mexico, and southwestern United States. Certain English anthropologists believe that this is evidence of diffusion from Egypt. Most American anthropologists believe that the irrigation technique developed independently in America.

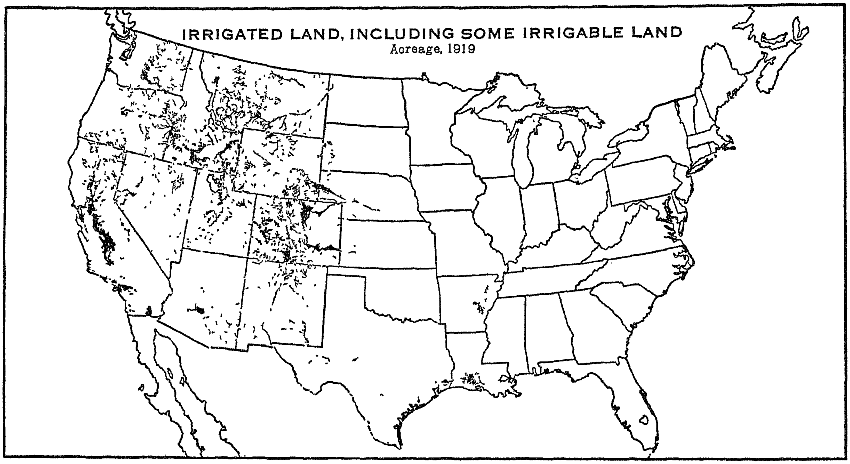


Figure 45. Note how the irrigated lands mark out the important river valleys. (Courtesy of the U. S. D. A.)

The Physical Factors. The first and most obvious requirement for irrigation is a supply of water. The areas needing irrigation have scant rainfall so that most of the water used must come from areas of greater rainfall some distance away Thus, the water of the Nile which makes Egypt habitable falls as rain on the mountains of Ethiopia and the Central Plateau of Africa; the water of the Colorado which is used for irrigation in its lower course is derived from rains and snows far away on the Rockies. Both rivers lose tremendous quantities of water by evaporation as they pass through dry regions. The portions of dry regions which are within easy reach of streams or underground waters are decidedly limited, and this lack of water is the greatest single factor limiting irrigation.

In addition, the water should be available in such a position that it may flow onto the land by gravity or be raised to the level of the fields very cheaply. Throughout a portion of its course, the Colorado flows through a canyon a mile below the dry lands. This is an extreme example, but to a greater or less degree many streams are useless for irrigation purposes for this reason.

Ironically enough, land which is irrigated must also be drained. If water is allowed to stand in a field and evaporate, or to soak into the soil and then evaporate, it deposits the salts held in solution and may eventually render the land unfit for use. Thus, the topography must be such as to allow for drainage, as well as for irrigation.

In addition, there are many special physical features which determine whether irrigation is possible. Narrow canyons, for instance, are easier to dam and make better storage reservoirs than broad valleys, because they store large volumes with a small area of surface from which water may be rapidly lost through evaporation into the dry air. Water with silt in it enriches the fields but tends to clog the irrigation ditches and fill up the storage reservoirs. Some wells used for irrigation flow of their own pressure; others require pumping. Some streams have a steady flow and others are quite erratic. These are but a few of the physical factors which help to determine whether a given region may be irrigated.

The Economic Factors. In a given project it may be *possible* from an engineering standpoint to "make the desert bloom as the rose," but it may not be *profitable* to do so. In the nineteen states of the United States in which irrigation is important, the cost of plant and structures necessary to irrigate the land ranges from $19.80 per acre in the Louisiana rice districts to $88.97 per acre in Arizona and averages $39.57 for all the states. In addition, it is estimated that it costs, on the average, $28.21 per acre to

grade and otherwise prepare each field to receive water.

If the irrigation farmer is raising crops in competition with the farmer who has none of these costs because his land receives sufficient rainfall, he starts at a disadvantage. In addition, because he is located in dry lands, he is likely to be far from market and to be subject to high costs of transportation. In many instances, these disadvantages are partly or wholly overcome because the soil is naturally good and the supply of moisture is controllable. For these reasons the yield per acre of the irrigation farmer may be larger than that of his competitor in the moister regions.

The irrigation farmer may be favored, also, by an ability to grow crops which do not compete to any considerable extent with those of the moister lands. This is especially true for certain of the citrus fruits—such as grapefruit and lemons—and dates and figs. In other products, such as long-staple cotton, he is able to grow a product which is superior to that grown elsewhere. In the tropical or subtropical climates he has the additional benefit of a year-round growing season which often makes it possible for him to grow vegetables for sale in middle-latitude markets in the latter's winter.

In some irrigation districts, the inhabitants are producing largely for their own needs and the competitive situation is of less concern to them. Even in the oases of the Sahara, however, there is usually some trade and the cash crop must be some such item as dates or figs which does not compete with the cheaper products of the wetter lands and which can stand high transportation costs.

The balance between the favorable and unfavorable factors in any given irrigated region is usually quite close. Land[1] usually costs more than in wetter regions for the reasons given above, and markets are usually a problem. The most profitable irrigation developments in the past have been those in which the physical problems were the simplest and least expensive to solve. Thus, in the United States, the returns for the Census of 1930 show that 66.4 per cent of the total area irrigated was supplied by water from streams which flowed onto the fields by gravity—the cheapest possible source of water. Water was pumped from wells to but 10.5 per cent and from streams to but 8.8 per cent of the area.

In the very nature of things, the older projects tend to be most successful because the areas which could be irrigated by a cheap dam and ditches which might be constructed by an individual, partnership, or cooperative were developed first. The costs of these were small and little capital was involved. The developments requiring expensive dams and storage were left for corporations or governments to undertake and, because of the expense involved, start out under a handicap. If they had been cheap, they would not have been left for government development. The individual or partnership and the local cooperative were responsible for watering about 65 per cent of the irrigated area of the United States in 1930. It is interesting to note that this is almost exactly the proportion irrigated from streams by gravity.

[1] Unimproved land is often low in price, but the water rights which are necessary for the agricultural use of the land are expensive.

Dry Farming. This is a technique for using rainfall to raise crops in semiarid regions—that is, regions in which some rain falls, but it is too small or too irregular to be depended upon. It operates on the basis of using more than one season's rainfall to raise one crop. The dry farmer does this by allowing the land to lie fallow for one or more seasons and by harrowing or plowing the field after each rainfall. This cultivation stores the rainfall until the appropriate time when the crop is planted. It is prevented from evaporating into the dry, thirsty air by covering the surface with straw, or other material, or so cultivating the soil that a fine dust is formed on top which keeps out the heat of the sun (these practices are known as *mulching*). While it is growing, the crop obtains its water supply from the moisture stored in the soil, plus the rain falling during the growing season. Dry farming has become important in the semiarid regions in the western United States during the last fifty years and has been practiced in the drier parts of the Old World for centuries. It should be noted that this dust mulch is, as the name would imply, very light; therefore, dry farming probably contributed to the causes of the dust storms which were so damaging in the center of the United States in 1934 and 1935.

QUESTIONS FOR DISCUSSION

1. How might the development of irrigation lead to the establishment of a strong central government?
2. It has been said that the government of the United States is extending the land under cultivation by financing irrigation at the same time that it is trying to retire much land from use. What are the factors involved?
3. Why would large cities be impossible in the form in which they exist today if there were just enough water for drinking and cooking?
4. Why has land in dry farming in the United States been increased by the use of power-driven machinery?

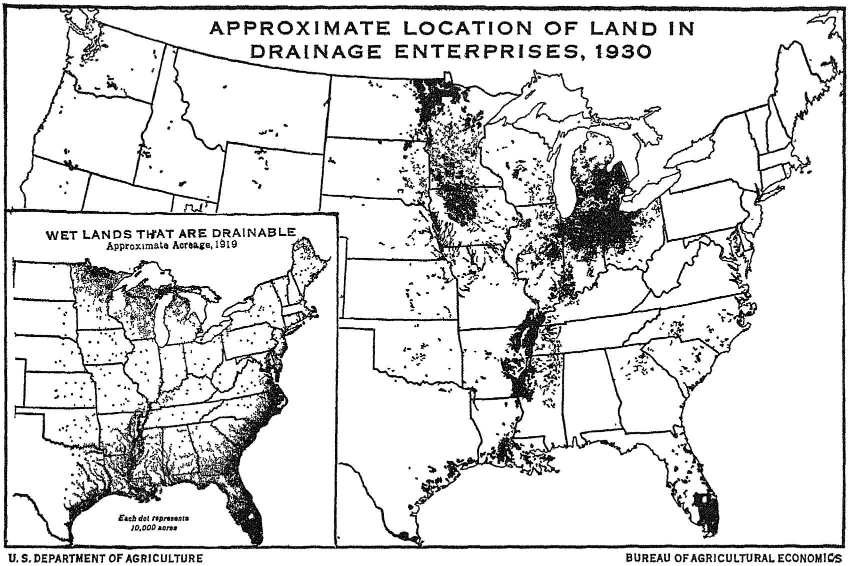


Figure 46. Glacial plains, flood plains, and coastal plains account for most of the drainage problems in the United States.

Drainage and Flood Control

Too much water is almost as great a handicap as too little, hence drainage and the control of floods have been among man's urgent problems since he first settled in river valleys and other low-lying lands. As in irrigation, these problems encouraged cooperation and the formation of governments because the efforts of one man were insufficient to affect the dominant environmental factor. The Nile Valley presents problems both of flood control and irrigation, but the valleys of China are the outstanding regions in which teeming populations, living on soil made rich by rivers, are in continuous peril from flood. Perhaps the early rise of civilization in China was in part a response to the problems posed by the necessity of curbing the rivers. Certain it is that a government in China embarked on attempts to meet the problem as early as 2255 B.C. Since that time, and probably earlier, throughout the world, men have been struggling to control the waters so that they may live in the low rich lands that are most suited to agriculture. Fortunately, the area of land in the world that is subject to flood or needs drainage is much smaller than that needing irrigation. In many instances, however, it is much more significant land because it is densely populated.

As with irrigated lands, the lands needing drainage which could be simply and cheaply drained were ditched and diked long since, and only the great projects requiring tremendous investment and involving legal problems have been left to governments. The greatest development of drainage has taken place in those countries where population was dense and good land scarce. The Netherlands is, of course, the outstanding example. With a small area and much of that poor in soil, the Dutch reclaimed the low tidal marshes at great expense by diking them and using wind power to pump out the water. Roughly one quarter of the present area of the Netherlands has been reclaimed in this way. In the British Isles, in part because of the heavy rainfall and in part because of the low rate of evaporation, much of the soil is considerably improved by drainage, and it has been a common practice for centuries. In the United States, the Census of 1930 reported 45,000,000 of the

987,000,000 acres in farms as being supplied with some form of artificial drainage Significantly, a great deal of it was in the northern Corn Belt, where glacial clays interfered with natural underdrainage and where the rate of evaporation was low—with a consequent tendency for the soil to become sour.

The Conservation of Water

Conservation is best defined as *wise use*. The ideal situation from the standpoint of conservation of water, alone, would be for man to act so that every drop that fell as rain or snow would do the least harm and the maximum good. Under such a program, land in farms would be so managed that there would be the maximum of soak-in and the minimum of immediate runoff Land not in farms would be kept in forest and grass wherever possible. In addition to power dams at appropriate sites on streams, there would be diversion basins and flood-control dams to impound high water and let it out in periods of drought. Business and transportation interests would be prevented from encroaching on the channel of the stream with buildings and bridges which might impede the flow of water and serve as unwanted dams in periods of high water. Areas subject to flooding in spite of such control might be removed from use for industrial or residential purposes so that there would be the minimum of loss in flood time. Sewage and industrial wastes would be so treated that they would be harmless when entering streams. On floodplains additional emergency channels would be provided to help the river carry its load in times of high water. The diversion of water for irrigation or industrial use would be regulated in the light of the greatest benefit to all users. The lack of pollution and the requirement of fish ladders in dams would assure a proper habitat for and unlimited circulation of fish.

Some conservationists like to dream of a day when a great river system such as the Mississippi will be managed by a "dispatcher" who will sit at a central control point and receive a constant flow of information from observers all over the basin. If there is heavy rainfall or rapidly melting snow on the upper river, he will order the opening of spillways to diversion basins and the closing of the gates of flood-control dams in order to check, temporarily, the flow and release it gradually. He will, by "playing" his dams and spillways as an organist plays his stops, "conduct" most floods safely to the sea, and maintain water-levels in dry periods. In unusual circumstances, such as continued rains in the lower basin of the river, he will be able to foresee levels in advance and give warnings in time to prevent great loss.

Some Difficulties. Some of these conservation practices are already in effect and more will undoubtedly be adopted, but a complete program of water conservation on a large scale is an ideal that may never wholly be realized. Man does not live for the sole purpose of making the most of his water resources. He is so often interested in other things that it is hard to convince him that he should go to the expense or make the changes in his mode of living necessary to make such an ideal realizable. In addition, there are "vested interests" to which some of these practices would be a distinct disadvantage or, indeed, downright disastrous. These vested interests are by no means exclusively large corporations. The small farmer may find it difficult and expensive to change his whole system of farming in order to adopt measures to conserve water and prevent erosion. People living in regions subject to flooding may be reluctant, or even financially unable, to move. Lowland China, for instance, is so crowded that people *must* live on the flood plains, and they are so poor that they have no means to finance even temporary removal. Upriver dwellers may be reluctant to change their mode of living for the benefit of those down-river and the apportionment of the cost of measures taken is often a very difficult problem.

The legal problems involved are sometimes so great as to seem insurmountable. Legal forms and governments have grown up without much relationship to the control of water resources on a large scale. Conservation may require fundamental changes in vital concepts of law and government which people are reluctant to make because of their effects on other aspects of their living. Frequently political jurisdictions cut straight across drainage basins. For example, rain falls on Switzerland and flows off to the seas through Germany, France, Italy, the Netherlands, and the Danubian countries. The control of the Mississippi, Colorado, and Tennessee basins have given rise to compacts, agreements, governmental institutions which have not been attained without bitter opposition.

QUESTIONS FOR DISCUSSION

1. Which is apt to be socially and economically most desirable in the United States, the drainage of wet lands or the irrigation of dry lands? Why?
2. What fundamental legal concepts might need to be altered if the management of stream basins as a unit were to be undertaken in the United States?
3. Why will the "ideal" system of water conservation described above probably never be realized?

CHAPTER 10

WINDS, PRESSURE, AND OCEAN CURRENTS

WIND, in literature and folklore, is usually considered an index of weather. Because the direction of the wind was associated through long experience with certain types of weather, it was used for centuries before a science of forecasting was developed as a common and remarkably useful means of foretelling the weather. Some winds were warm, some were cold, others brought rain, and still others clear, cool weather. In addition, wind served man as a propeller of ships and windmills or was destructive to his crops, his buildings, and his ventures by sea.

The average city dweller of today is apt to think of wind as something which enters into his life to only the slightest degree. To him, wind seems to be merely an agency that makes warm days seem cooler and cold days colder, and blows umbrellas inside out. Actually, the wind still affects the kind and amount of shelter he occupies and, through its effect on agriculture and transportation, the cost of his food and clothing. Wind may even determine where he may or may not live, for one part of the world is desert and another part is moist largely because of the direction of the winds.

Wind and Its Measurement. Movements of the air which take place parallel, or roughly parallel, to the earth's surface are called *winds*. Other air movements—such as upward or downward motions—are known as *currents*. A wind is named from the *direction from which it blows*. For example, a wind blowing *from the west* is a *west wind.*

The velocity of wind is usually stated in miles per hour. In general, velocities of 0 to 20 miles per hour are not unfavorable. Velocities of 20 to 40 miles may be unfavorable, and velocities above that are usually destructive. The terms "breeze," "storm," "gale," and "hurricane" are very loosely used by laymen. The correct classification is shown in Fig. 47.

Figure 47

CLASSIFICATION OF WINDS BY VELOCITIES

Description	*Miles per hour*
Calm	0
Light	1-2
Gentle	3-5
Fresh	6-14
Brisk	15-24
High	25-39
Gale	40-59
Storm	60-79
Hurricane	80 or more

Atmospheric Pressure. The earth is surrounded by a gaseous substance known as *atmosphere*. This atmosphere or "the air," as the layman thinks of it, is substantial enough to have appreciable weight. On the average, the air above a square inch of surface at sea level weighs about fifteen pounds. The weight of the air, or the *atmospheric pressure,* is measured by an instrument called the *barometer.* The original barometer measured pressure in terms of the height in inches to which it would send mercury in a tube in which there was no air. Since January, 1940, the U. S. Weather Bureau has recorded pressure in terms of a metric unit, the *millibar,* which is a pressure of 1000 dynes per square centimeter. Because the "pressure" is actually the weight of the atmosphere *above* the barometer, it follows that the pressure will decrease if the barometer is carried above sea level. This is one of the convenient means of measuring altitude and is the principle employed in the surveyor's aneroid and the altimeter.

The actual pressures at sea level vary from place to place and from time to time at the same place. The most important factors operating to bring this about are variations in temperature and in the moisture content of the air. Since warm air is lighter than cold air, there is a tendency for the warm parts of the earth to have lower pressures than the colder parts. In addition, moist air is lighter than dry air and this causes further differences in pressure.

Wind is simply the movement of air from areas of higher to areas of lower pressure. The difference in pressure in a given distance is known as the *pressure gradient.* If the pressure gradient is *steep* (that is, falls sharply in a short distance), the wind will be strong,

The Wind Belts

The world has a systematic wind circulation which is due to the nature of the earth, its form and motions, and the fact that its heat comes from a single source—the sun. The wind belts may best be understood by considering the idealized wind belts, such as would be present if the earth's surface were smooth and entirely covered by water. These wind belts are shown in Figs. 48 and 49. The winds as they actually exist (on the average) over the oceans appear in Figs. 51 and 53. On these maps the important wind belts can still be recognized, although the distribution of land and water has caused some complications Winds over the lands are not shown because, while in general they are but the landward projection of the directions over the oceans, local topography and many other factors may actually cause them to vary considerably from the "prevailing" direction as shown here.

The Doldrums or Equatorial Calms. Due to differences in insolation (as explained on pages 56-57), the earth is heated unequally and the warmest area on an idealized globe would be in the tropics. Here the warm, light air rises and forms the almost windless area known as the *doldrums*. There is considerable movement of air here, but since it moves directly upward, it is not classified as wind and is hardly perceptible on the surface The warm air, as it rises, expands and cools and gives rise to heavy precipitation. The belt of heavy rainfall around the earth close to the equator is very largely the convectional rainfall of the doldrums. Where there are no complications due to topography land in this belt is occupied by a tropical rainforest.

The Trade Winds. The light, warm air of the doldrums is under low pressure and, consequently, air from high-pressure areas to the north and south of the equator flows into the doldrums. This equatorward flow of air forms the *trade winds*. Because of the rotation of the earth, they do not blow directly toward the equator but are partially deflected. This deflection may be stated as a general rule, known as Ferrel's Law: *In the Northern Hemisphere any moving mass of air is deflected to its right and in the Southern Hemisphere to its left.* Hence, in the Northern Hemisphere, the trade winds, instead of blowing from north to south, are deflected to the right and blow from northeast to southwest. Therefore, they are called the *northeast trade winds* and, in accordance with the same law, those in the Southern Hemisphere are deflected toward the northwest and be-

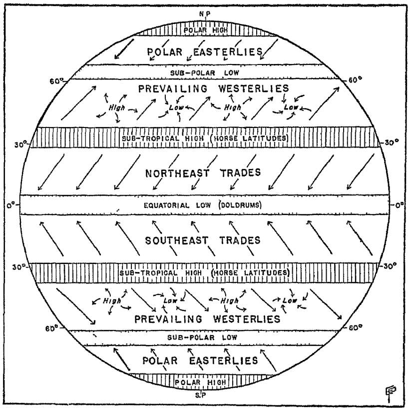


Figure 48 An idealized diagram of the wind belts of the world In the prevailing westerlies, cyclonic disturbances, each with its own wind circulation, move from west to east around the world. The latitudes of the belts are only approximate and vary with the seasons.

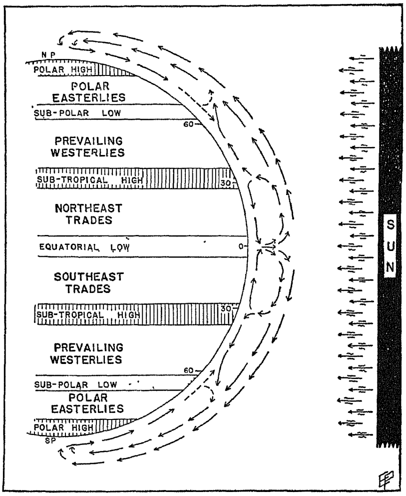


Figure 49. Diagram to show the horizontal arrangement of winds above the earth's surface at various latitudes The sun's rays are shown as they reach the earth at the equinoxes. The highest winds represented are at a height of 15 miles (at the equator).

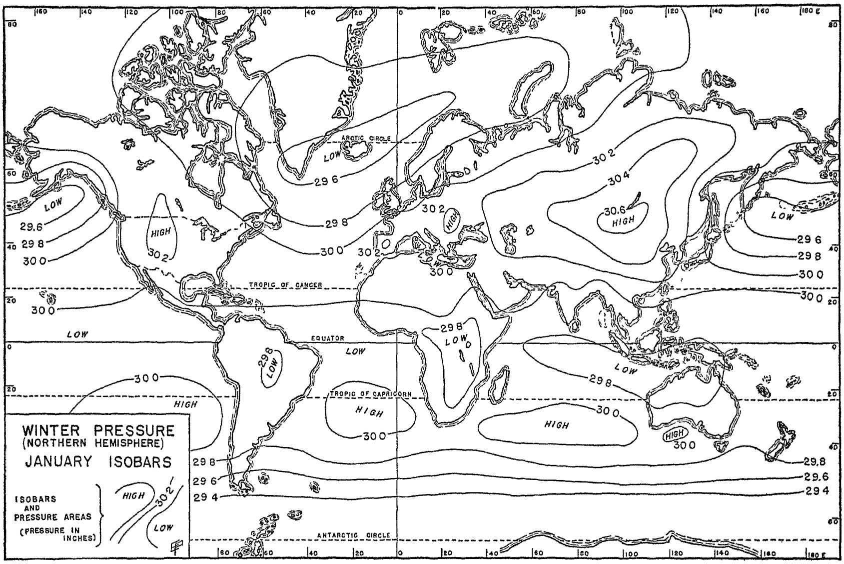


Figure 50. The pressures have been reduced to sea-level equivalents.

come the *southeast trade winds.* The trade winds are very steady in direction and force and received their name because of their dependability as a propelling force for vessels.

In its simplest form, the climate of the trade-wind belts is represented by the low-latitude deserts such as the Sahara, the Arabian, the Kalahari, and the Atacama. Low-latitude steppes are a modification due to slightly greater rainfall. The dryness is due to the fact that these winds in passing from the horse latitudes to the doldrums are blowing from higher latitudes (cooler conditions) toward the equator (warmer conditions), so their power to hold moisture is being *increased.*

Within these belts, however, occur some areas with very high rainfall. In Figs. 40 and 41 this may be observed to be true in the West Indies and in other mountainous regions within the belts. In all of these instances, the high rainfall occurs because the trades blow against mountain ranges and are thus forced to ascend and are cooled. This brings about considerable rainfall at even slight elevations, because the winds of the islands and windward coasts have usually been blowing over the sea for considerable distances and have, therefore, a high *absolute humidity.* The amount of rain depends largely on altitude. Where rainfall is heaviest on these windward coasts in the trade winds, tropical rainforest is as typical as in the doldrums.

The Horse Latitudes. The air which rises in the doldrums is cooled in the upper atmosphere and then flows poleward. Some of it is able to settle down at approximately 30° north and south latitude. Because it is descending air and is cool, there is a zone of high pressure (see Figs. 48, 49, 50 and 52) which is called the *horse latitudes.* From this high-pressure area, air flows, at the earth's surface, both north and south in both hemispheres. The air flowing equatorward becomes part of the trade winds, that flowing poleward becomes the *prevailing westerlies.*

The horse latitudes are dry because the air movement is from the cool upper atmosphere to the warm earth's surface, as indicated above. They affect very little of the land surface because they do not extend their influence far over the continents. Even when they do, since they are next to the prevailing dry

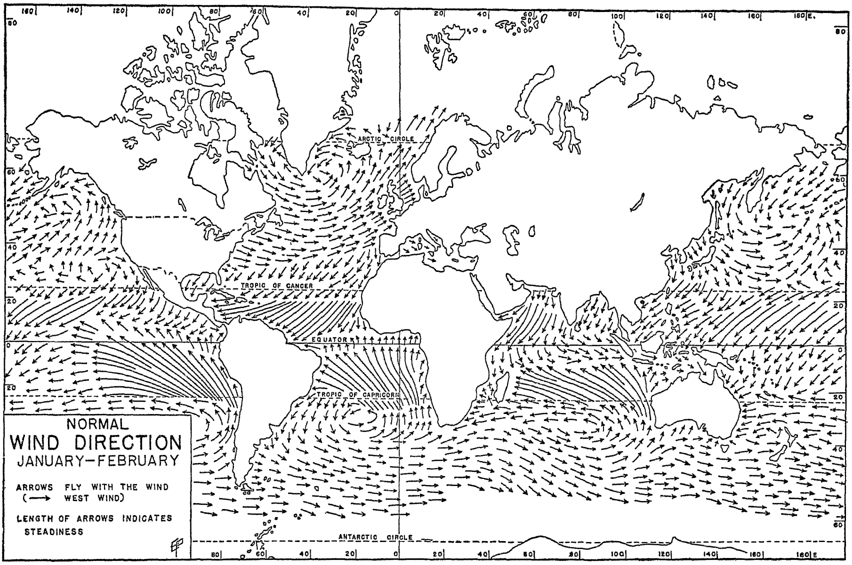


Figure 51. The winds over the land are often irregular because of the deflection caused by topography and convection. Within the prevailing westerlies, the passage of cyclonic storms alters the wind pattern considerably

trade winds it is difficult to determine how much of the dryness is due to high pressure and how much to trade-wind influences. They are of most importance in the region of the Mediterranean Sea and the west coasts of continents where the high pressure over the ocean influences the most land.

The Prevailing Westerlies. The air moving poleward from the horse latitudes is deflected by the earth's rotation and forms a southwesterly wind in the Northern Hemisphere and a northwesterly wind in the Southern Hemisphere. The latter wind is fairly steady and very strong, for there is little land to interrupt its course around the Southern Hemisphere. The prevailing-westerlies belt in the Southern Hemisphere is frequently called the "roaring forties" because of its strong winds.

In the Northern Hemisphere, the westerlies pass over huge land masses and many major relief features. These, and the prevalent cyclonic storms (described on pages 84-85), make the direct influence of these winds less striking and less universal than in the tropical wind belts.

There can be no general description of this belt as either *wet* or *dry*. Rainfall conditions here depend on a complex of conditions including local prevailing wind direction, the distribution of land and water, topography, the extent of the monsoon[1] influence, and the intensity and frequency of cyclonic storms.

It is possible, however, to point out some general relationships between the fact that the wind is more often from some variant of a westerly direction than any other and the amount and distribution of rainfall. The rainfall map inside the rear cover will indicate that there is heavy rainfall on the west coasts of all continents which extend into the latitudes (approximately 35° to 60°) occupied by these belts. Given a wind blowing most frequently from the ocean to the land, such a condition is easily explainable. As indicated above, the land will be cooler than the sea in winter and this would account for rainfall at that season. If, in addition, there are any considerable elevations for it to cross after it strikes the land, the rising of the wind which is brought about by the

[1] See page 82.

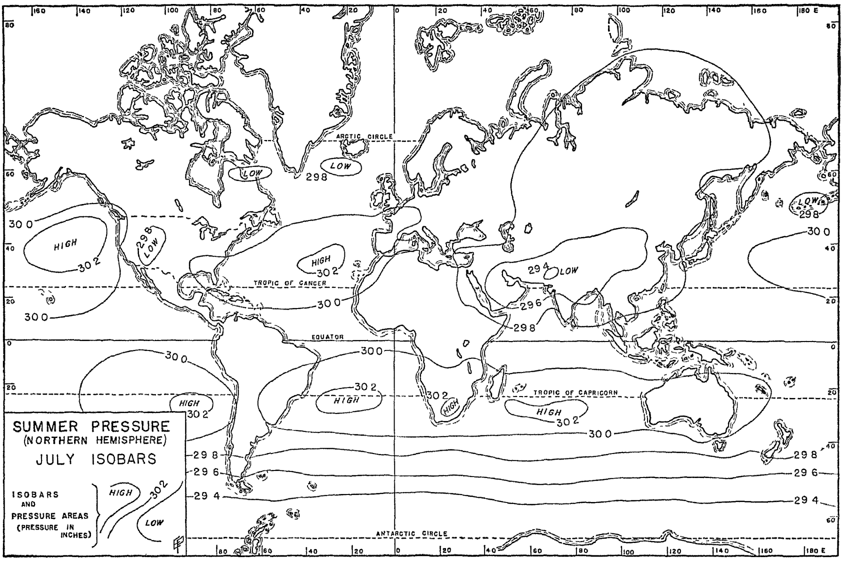


Figure 52. The pressures are reduced to sea-level equivalents.

topography is also likely to cause rain. It will be noted that on the west coasts of North and South America in this belt there is a zone of heavy rainfall marking the mountainous regions close to the coast and a "rain shadow" of dry country to the eastward. In Europe, the relation between prevailing westerly wind, rainfall, and topography can best be noticed in Scandinavia, the British Isles, and the Iberian, Italian, and Balkan peninsulas, each of which has a rainy western side and drier eastern one. The prevailing westerly wind is not the whole explanation for rainfall in these places, but it is the major control.

The eastern portions of land masses within the prevailing-westerly belts would be dry if there were no other influence than a prevailing westerly wind However, the presence of cyclonic storms, each with its own wind circulation, accounts for a considerable rainfall, even well inland from the eastern coasts in these latitudes. These storms are important controls of the humid continental climates which occupy the eastern parts of North America and Asia.

The Polar Belts. The subpolar low-pressure belts do not usually extend over the lands (see Figs. 50 and 52) and cause, therefore, very little precipitation on land. In the ocean areas covered by these belts there is considerable rainfall and in the Southern Hemisphere where the belt extends practically continuously around the earth it is apparently stormy most of the time and has tremendous precipitation.

The polar high-pressure and subpolar easterly belts are, apparently, very dry, although insufficient data exist as yet to allow for detailed knowledge of the climate in these regions. Dryness would seem to follow from the fact that the air is coming down from the upper atmosphere and that the low temperatures prevailing would allow the air to hold very little moisture at any time. The polar icecaps, the great tundra plains of the arctic, and the subpolar forests lie in these belts.

QUESTIONS FOR DISCUSSION

1. How may wind determine where man may or may not live?
2. Why is the Sahara the largest desert?
3. In what wind belt is most of the United States? If the wind blew all of the time from the direction indicated in the name of that wind belt, what would be the rainfall condition in the eastern part of the United States?

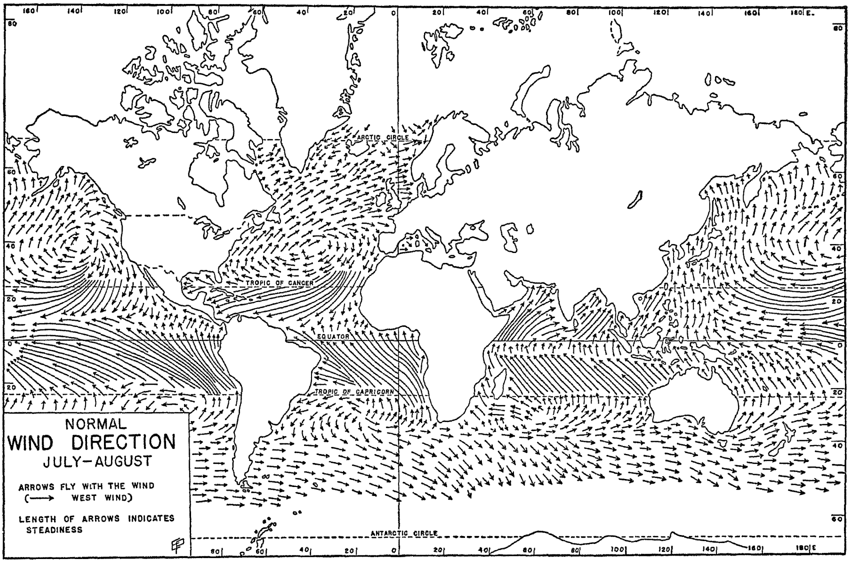


Figure 53.

Actual Pressure and Wind Conditions

Heretofore, the discussion has proceeded upon the basis of assumptions designed to eliminate complicating factors. Figs. 50 through 53, however, show the mean isobars and winds for January and July. These illustrate the extremes between the seasons, and the movement of the pressure belts northward and southward with the seasonal migration of the maximum insolation. There are numerous factors which tend to upset the generalized circulation presented in Fig. 48. Several of the most important are discussed below.

Seasonal Migration of the Wind Belts. The wind belts, as outlined above, migrate to some extent northward and southward with the *apparent* migration of the sun from season to season. This is an obvious result of the differential heating power of the sun which is largely responsible for the major circulation in the first place. The belts do not, however, move as much as the sun's vertical rays. The belts near the equator (the equatorial calms, the two trade-wind belts and the horse latitudes) appear to move the most and the belts in the higher latitudes (with the exception of the equatorward edge of the prevailing westerlies) appear to move very little.

The migration of the belts accounts for several types of climate which have, at different seasons, characteristics of each of two adjacent belts. For example, the tropical savannas (mixed grassland and open forest) are transitional between the low-latitude deserts, under the influence of the trade winds throughout the year, and the tropical rainforest with its predominant doldrum influence. When the doldrums shift poleward in summer, they bring a season of more or less heavy rain When they return equatorward, trade winds take over control of these savannas and the season is dry.

The climate of the Mediterranean regions is also a transitional one due to the shifting of the belts. This climate occurs on western coasts astride the horse latitudes and the equatorward edge of the prevailing westerlies. In winter when the belts have shifted toward the equator, the westerly winds and cyclonic storms of the prevailing westerlies bring rain. In summer, the high pressures of the horse latitudes prevail and the season is dry.

The Monsoon Effect. The generalized wind circulation pictured in Fig. 48 was based on the assumption that the surface of the earth was of uniform material: could everywhere be heated and cooled at the same rate. However, this does not represent the true facts. The land of continents and islands heats and cools much more rapidly than the surrounding water. In addition, there is more land in the Northern Hemisphere than in the Southern, so the former would become both hotter and cooler than the latter, given the same amount of insolation. This is the true condition and the resulting wind movements are of such strength that they considerably modify the generalized picture presented in Fig 48.

The Land and Sea Breeze. The effect which the distribution of land and water has on the wind direction may perhaps be illustrated by starting with an analysis of the local land and sea breezes which are common in coastal districts, especially during the warmer seasons. If the temperatures over the land and water are assumed to be equal and the air absolutely calm at sunrise, the temperature over the land will rise more rapidly than that of the sea as the day goes on. As a result, the warmer, lighter air over the land will be replaced by the cooler, heavier air over the sea; that is, the greater heat of the land will develop a low-pressure area as compared with the cooler sea, and the wind will move from the higher to the lower pressure, that is, from sea to land. In the evening, the land will cool more rapidly than the water and a point will soon be reached at which the land becomes cooler than the ocean and the pressure differentials will be reversed, thus causing a flow of air from the cooler land (with the higher pressure) to the warmer sea.

The Asiatic Monsoon. If this same principle is applied to the major land masses and the surrounding oceans—and studied, not in terms of changes of temperature between day and night, but between the seasons—the explanation for the most radical departures from the generalized circulation outlined in Fig. 48 will stand revealed. The principle affects, to some degree, even the smallest land bodies but reaches its most important development in the greatest of all continental units—the great Eurasian land mass. As the sun's more direct rays move northward in the Northern Hemisphere summer, they heat this great land mass much more rapidly than they do the surrounding oceans and seas. The greater heat of the land causes an area of lower pressure to be built up there, and the wind flows in toward this low from all directions. The pressure gradient between the cool sea and the warmer land is so great that the northeast trades and the prevailing westerlies are completely reversed about the coasts of Asia in this season. (Figs. 52 and 53.) The onshore wind in summer resulting from the low-pressure area over Asia is called the *monsoon* and gives its name to the general effect causing it. The monsoon is usually accompanied by heavy rainfall, because the light, warm, moist air rises as it passes over the hot land.

In the winter season, the land cools much more rapidly than does the surrounding water. As a result, the pressure over the land becomes higher than that over the oceans, so the wind flows outward from the land. (Figs. 50 and 51.) This wind is called the *antimonsoon.* This cool descending air out of the heart of the Asiatic land mass usually brings a dry season

The combination of the monsoon and antimonsoon has been recognized and used by traders and sailors for centuries. Before the time of the Crusades, the Arabs had been using the monsoon to drive their crude sailing craft to India in the early summer and the antimonsoon to blow them home again in the winter. Because the alternate wet and dry seasons of the monsoon and antimonsoon give rainfall results like those arising from the succession of doldrums and trade winds, much of southeastern Asia has a savanna type of vegetation. In some parts of extreme southeastern Asia where the wind is blowing off the water whether the monsoon or antimonsoon is blowing (as in the islands of the East Indies), tropical rainforest conditions prevail.

Other Effects of the Distribution of Land and Water. In addition to the great Asiatic monsoon, there are lesser monsoon effects associated with every large land body and, locally, acting to upset the generalized wind circulation. Only a detailed analysis of the climatic controls of each continent would serve to reveal these fully.

The generalized wind belts are apparently much more apt to represent true local conditions over the seas than over the lands. This is largely because the oceans are relatively uniform in surface, one of the important assumptions made when the idealized wind circulation of the globe was first presented.

Mountain Winds. In mountainous country, there is often a reversal of wind direction from day to night. The upper slopes are most exposed to the direct rays of the sun and heat up considerably during sunny days. The air in contact with them is heated, rises, and air from the valleys rises to take its place. At night, these upper slopes cool more rapidly than the lower slopes, the air in contact with the upper slopes

is cooled and moves down, pushing the lighter warmer air out of the valleys. Such air movements are known as *mountain and valley breezes.*

Another type of mountain wind may be illustrated by the hot, dry wind known from Colorado to Alberta as the *chinook.* Whenever atmospheric conditions are such that a strong wind is forced up the western slope of the Rockies, the rising air loses most of its moisture before descending the eastern slope to the level of the Great Plains. The descent compresses the air, raises its temperature, and increases its capacity to hold moisture. Similar drying winds in Switzerland are known as *foehn* winds.

QUESTIONS FOR DISCUSSION

1. What evidences of the equatorial calms, the horse latitudes, and the subpolar belts of low pressure are found on the maps, Figs 50 to 53?
2. What evidences of the Asiatic monsoon and antimonsoon are found on each map? Where is the area of highest pressure in January? Where is the area of lowest pressure in Asia in July?
3. Does a wind belt have the same influence on both the eastern and western margins of continents?

Major Ocean Currents

There is a very close connection between the major ocean currents and the wind circulation shown in Figs. 51 and 53. Many factors affect the direction and rate of movement of ocean waters, but prevailing winds are largely responsible for the major surface currents. This is demonstrated most forcefully in the zone of the most dependable winds—the trade winds. These winds, blowing from the northeast and the southeast, drive the surface waters over which they blow toward the equator and toward the west. Thus, there is a great westward *equatorial current,* or *drift,* in the seas about the equator.

If there were no continents to impede their progress, these currents would be continuous around the world As it is, each splits against the continent to the west and is deflected to the north and south. In each ocean basin, there tends to develop a whirl, with the water moving, in general, poleward in each hemisphere in the western part of the basin. In the eastern part of each basin, the water tends to move equatorward.

This general rule is modified in the north Atlantic because the trend of the western coast of Europe allows warm water from the Gulf Stream Drift to be driven far northeastward, even into the Arctic Ocean, by the prevailing westerlies. This water makes the coast of northwestern Europe warmer than might otherwise be expected at that latitude. It must not be thought, however, that the Gulf Stream Drift is the only reason why western Europe is more temperate than the opposite coast of North America. On the European coast the prevailing winds blow off the water; on the North American coast, off the land. This variation accounts for a considerable difference in temperature.

The North American coast as far south as Cape Cod is chilled by the cold *Labrador Current,* which flows out of the Arctic Ocean between Greenland and Labrador. The ice which the glaciers of Greenland push into the sea is carried southward by this current and becomes the iceberg menace of the north Atlantic shipping lanes. Fogs are common on the Grand Banks where the Labrador Current meets the warm Gulf Stream.

In the western part of the northern Pacific basin, the *Japanese Current* follows a similar northeastward movement, but the westward projection of Alaska prevents much of this warm water from passing into the Arctic Ocean; it is deflected southward along the west coast of North America. As in northwestern Europe, both warm water and an onshore wind help to make the panhandle of Alaska and the coast of British Columbia temperate, considering the latitude.

In the south Pacific, the *Humboldt,* or *Peru Current,* which carries cold water from the Antarctic far to the northward along the western coast of South America helps to extend the west coast desert almost to the equator. Desert conditions on the northern part of the Chilean coast and the southern half of the Peruvian coast result from the rain shadow effect of the Andes in latitudes where the southeast trades predominate. However, on the northern half of the coast of Peru, the doldrums prevail a considerable part of the year. They would normally bring considerable convectional rain, were it not that the land is warmed by the overhead sun and the rising air is displaced by cold air off the water, and condensation, to say nothing of precipitation, can occur only if the air is carried to great heights. As a result, there is little or no rainfall at sea-level, though a zone of clouds, or "high fog," at a considerable elevation is common.

QUESTIONS FOR DISCUSSION

1. Consult Figs. 37 and 38 which show both isotherms and ocean currents. Are the isotherms near together or far apart in the eastern margins of oceans in the Northern Hemisphere? Is there any relationship between the behavior of the isotherms and the ocean currents in such a situation?
2. Where are there cold ocean currents off desert coasts? Is there any significance in this relationship?

CHAPTER 11

STORMS AND THE WEATHER

Atmospheric conditions in the prevailing westerly belts are generally unstable. Here change follows change so inevitably that weather has long been the commonest subject of casual conversation and the very assumption of changeability has given some most striking sayings to European languages. In English, alone, there are such universally understood phrases as "making hay while the sun shines," "fair weather friends," and "laying something by for a rainy day."

Within these latitudes in both Northern and Southern Hemispheres, a great "river" of air moves from west to east around the earth. As with many rivers of water, numerous eddies, whirlpools, waves, and counter-currents are carried along by the stream. As they pass, these atmospheric disturbances bring an infinite variety of wind direction—and therefore of weather conditions—to any point on the "bottom" of the "river." These "eddies" and "whirlpools" are due to differences of pressure in the air in various parts of the "stream."

The Polar Front Theory. It is now thought that these differences in pressure are caused by the overlapping of cold air from the polar high and warm equatorial air brought from the horse latitudes by the prevailing westerlies. It has already been indicated (page 80) that the subpolar low does not extend over the lands, thus the polar easterlies and the prevailing westerlies have contact, on the continents at least, along a line called the "Polar Front." This front must be thought of, not as a constant, straight line but as a wavy line which may move bodily northward or southward as polar or equatorial influences vary in strength.

The Low-Pressure Area, or "Cyclone."[1] The way in which a low-pressure area may develop along this polar front is indicated in Fig. 54. At A the warm air of the prevailing westerlies and the cold air of the polar easterlies are in contact, blowing in opposite directions. The friction along this line would

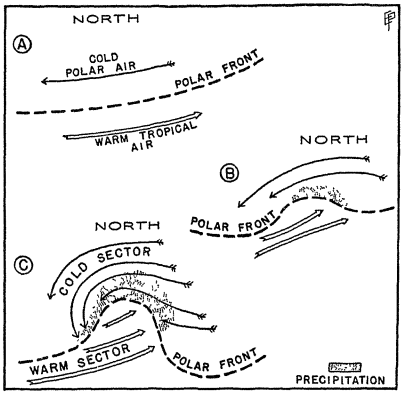


Figure 54 The development of a cyclone according to the Polar Front Theory.

be sufficient in itself to assure an unstable condition here. In B a bulge northward has developed in the line of contact. Now some of the warm air is blowing directly toward the stream of cold polar air. Because this cold air is heavier, it serves as an impediment and the warm air, instead of pushing it aside, is forced to rise over the cold. This warm air expands and is cooled as it rises and there is precipitation in the stippled area, not because of any considerable mixing of the warm and cool air, but largely because of the ascent of the warm. If the bulge grows deeper, as in C, there is a large stream of warm air pushing up over the cold air and the low pressure developed by the ascent of this air tends to pull both warm and cold air from all directions toward the point of minimum pressure at the earth's surface.

Figure 55 is a west-to-east vertical cross-section of such a low-pressure area. On the eastern side of the storm, warm air is rising on a gentle slope over the cold air. This is called the *warm front* because, as an

[1] This should not be confused with the so-called "cyclone" of the interior United States, which is a rotary storm of small area but of extreme violence. Such storms are really tornadoes.

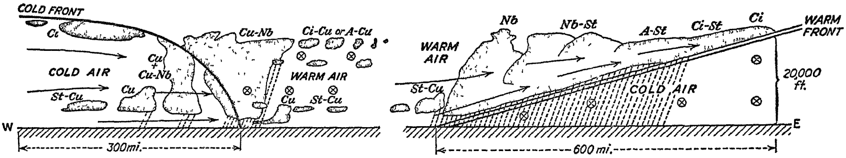


Figure 55. Vertical cross-section across a low-pressure area (Slightly modified from H. R. Byers, *Synoptic and Aeronautical Meteorology*, McGraw-Hill, 1937)

observer crosses this line from east to west (or as it moves past if the observer is stationary), there is a distinct change to warmer conditions. The slope of this warm front is so gentle that flyers approaching it at moderate altitudes from the direction toward which the storm is moving often encounter it 300 or more miles from the contact of this warm front with the earth's surface. Because of the low angle of the warm front, precipitation often occurs far ahead of the point of minimum pressure where the air begins its rise.

In the warm center of the storm where the air begins its rise, precipitation is usually not heavy because the ascent of the air is not great. On the west side of such a storm, however, the slope of contact between the warm air and the cold air is usually much steeper, and there is generally a narrow zone of turbulence and heavy precipitation. This contact—cold air moving in to replace warm air—is called the *cold front* or "squall line." In analyzing this diagram it must be kept constantly in mind that the area included in a cyclone may be 300 to 1000 miles in diameter at the earth's surface, that it has north-south as well as east-west dimension, and that it is being carried by the prevailing westerlies in some variant of an easterly direction

The High-Pressure Area, or Anticyclone. A high[1] develops as a tongue of cold polar air bulging southward on the polar front between two lows. It pushes in under the warm air of the westerlies and the cold air moves outward at the earth's surface in all directions toward lower pressures. Figure 56 shows the polar front with a tongue of cold polar air projecting southward between two northward-projecting tongues of warmer air from the prevailing westerlies. Sometimes these tongues of cold air separate completely from the parent cold air mass and move out from the front. They may then remain stationary for days, or even weeks, and lows may even pass to the poleward of them as waves on the "new" polar front.

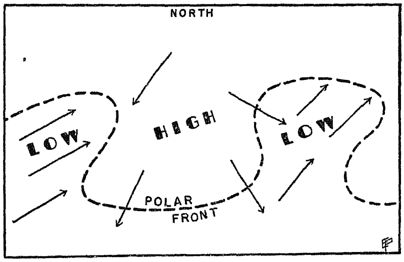


Figure 56. The formation of an anticyclone according to the Polar Front Theory

A high is not said to have any fronts of its own as the cold front preceding it and the warm front following are said to belong to the preceding and following lows. Because the high is a cold mass with air moving out from it toward lower pressures and warmer conditions, there is seldom any precipitation connected with it.

Wind Directions. In Fig. 57 a generalized low and a generalized high are presented as they might appear on a surface map in the Northern Hemisphere. In order to simplify the presentation, each is shown as existing by itself with its own wind circulation. Actually, as indicated above, each is part of the general interaction of pressure conditions existing at any given time. Isobars show the distribution of pressure, and arrows show wind directions. It will be seen that the wind circulation in both the high and the low responds to Ferrel's law as stated on page 77. As this figure represents conditions in the Northern Hemisphere, air movements tend to be deflected to the right. Winds moving toward the center of the low are deflected to the right and thus give a *counterclockwise* circulation about the center. In the case of the high, the winds move outward and, being de-

[1] In meteorological literature, high-pressure areas are referred to as "highs" and low-pressure areas as "lows."

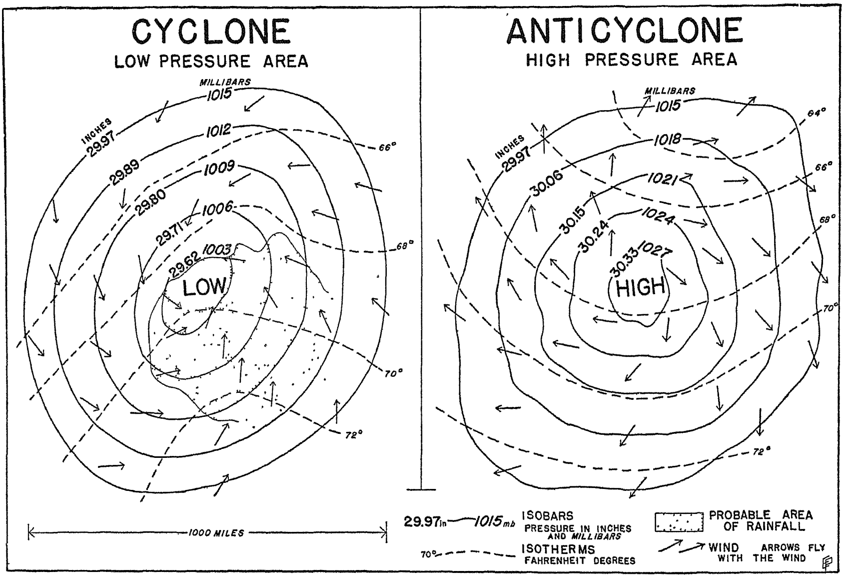


Figure 57. These idealized patterns are usually altered by relief, ocean currents, and other local conditions. In the Southern Hemisphere, conditions would be different because the higher temperatures are found to the north while the winds blow into the low in a clockwise direction and out of a high in a counterclockwise direction.

flected to the right, set up a *clockwise* circulation. In the Southern Hemisphere, because the deflection is to the left, the circulation is *clockwise into a low* and *counterclockwise out of a high.*

QUESTIONS FOR DISCUSSION

1. How might changeability of the weather tend to "civilize" the inhabitants of a region?
2. Describe the weather conditions you would expect if a low in the Northern Hemisphere were west of you. What would be the conditions if you were in the center of the low? What change would take place as the cold front passed?
3. Draw sketches showing pressure and wind directions about the center of a high and a low in the Southern Hemisphere.

The Movement of Storms. To realize the effect of cyclonic storms on the weather of a given place, some picture of their movements must be given. In general they move roughly from west to east around the earth with the prevailing westerlies. The rate at which they move varies locally, and from time to time, but a storm usually takes three or four days to move across the United States. The area coming under the influence of a given cyclonic storm may fall within a radius of 150 to 500 or more miles about its center.

As these storms move across the country, each carrying its roughly rotary wind circulation with it, they bring to any one place wind conditions—and, therefore, many other weather conditions—varying according to the origin of the air, the steepness of the pressure gradient, the season of the year, and the location of the center of the storm at various times in relation to the place under consideration.

A storm may take almost any path across the United States from west to east, but there are certain fairly definite tracks which are followed by a large number of storms. The common tracks are indicated in Fig 58. Winter storms are, by far, the most important because, in summer, cyclonic influence is weak and the sun is the most important control of the country's climate. This accounts in large measure for

the greater stability of the weather of most of the country at that season.

An analysis of Fig. 58 brings out certain important general facts as follows:

1. Most of the storms come into the country in the extreme northwest. This means that the central and southern parts of the Pacific Coast are little affected by this influence.
2. Many of the storms dip far to the southward, thus bringing changeable weather to portions of the South which might be expected, from a purely latitude standpoint, to be under the influence of the high-pressure calms
3. Most of the storms pass off the east coast in a northeasterly direction, usually from the Virginia Capes northward.

Summer storms are not only less frequent and less intense, but also tend to follow more northerly paths because the polar front is further north at that season.

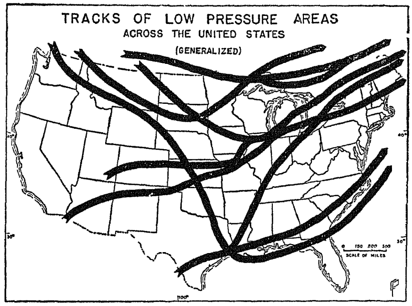


Figure 58. (After Van Cleef and others)

The Variability of Cyclones and Anticyclones. These storms have been called, above, "eddies" of pressure, and the term is apt. Like eddies in a stream, they are decidedly erratic in their behavior. There probably never were two storms which were exactly alike in all of their details, and even the same storm may increase or decrease in intensity, and in its rate and direction of movement, from day to day. For this reason, no attempt will be made to trace a "typical" storm across the country. An example of circulation and conditions around a high and a low will be analyzed to show some of their effects. This example will be confined to the area east of the Rocky Mountains because storms usually become more intense after crossing the Rockies and they are, throughout much of the year, the dominant controls of the weather in the eastern part of the country.

Analysis of a Storm. A weather map representing conditions which might prevail on a winter day is shown in Fig. 59. It will be seen that there is a low-pressure area with its center over the Great Lakes, a high-pressure area following it from the northwest, and another moderate high-pressure area to the southeast. Each has its typical influence on the wind directions. Air is blowing outward in a clockwise circulation from each high and inward in a counterclockwise circulation into the low.

The rainfall, as indicated by the stippled area, is largely confined to the central and southern parts of the low. The rainfall near the center and east of it is due to the rising of the air in the center of the low-pressure area and to the eastward of this center as the warm front "leans" forward in the direction in which the storm is moving (see Fig. 55 again). The southern part of a low is liable to be rainy in the Northern Hemisphere because, here, the surface wind has blown from the warm south to the cooler north. With the low centered in this position, there is the additional fact that, on its southern side, it is drawing moisture-laden air from the warm Gulf of Mexico.

The two highs have no rainfall associated with them, because high-pressure areas represent cold air descending and pushing outward. In addition, wind shown on this map as coming out of the northwestern high is blowing from some variant of a northerly direction and is, therefore, blowing from cooler to warmer conditions. Wind from the southeastern high must pass over a considerable distance before it encounters conditions markedly cooler than those from which it started.

Temperature conditions around the low can be easily derived from this map. Just east and south of the center, temperatures will be warm for this season because the wind is from the south. West of the center, temperatures will be cold because the wind is from the north and northwest. The southwest will be an area of transition. The wind will shift from the south to west, and then northwest as the cold front passes and temperatures will fall.

The condition represented here exists only for the moment for which the map is made. The United States Weather Bureau collects data for all of its stations, simultaneously, at 8 A.M. and 8 P.M., Washington Time (Eastern Standard Time) and then maps weather conditions for each of these times. Conditions may have shifted considerably a few hours later and, indeed, it is to determine not only what the weather is, but what it is likely to be, that these observations are made.

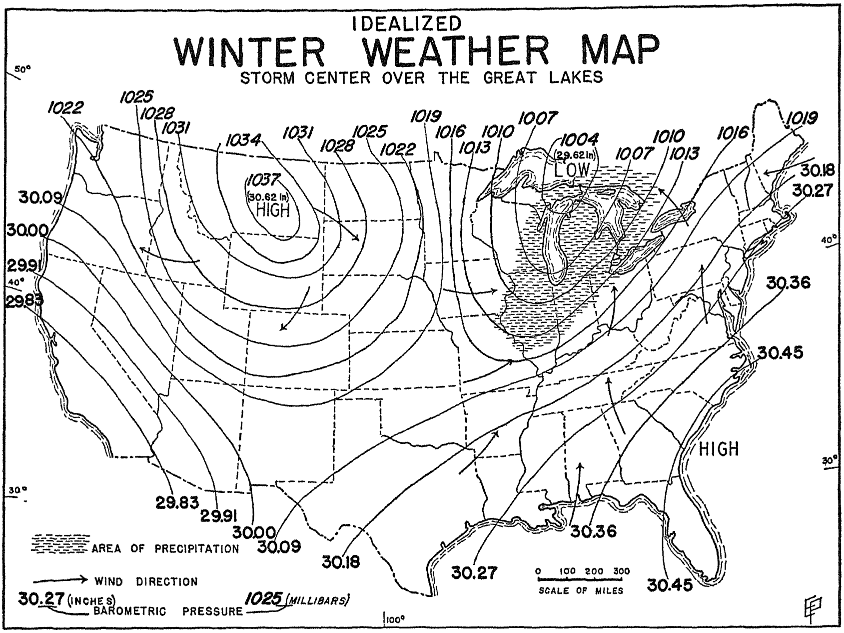


Figure 59 Barometric readings in millibars have been placed at the ends of the isobars along the Canadian border. The other barometric readings are in inches.

To show how a storm causes local variation of weather in its passage across the country, let us make a rough forecast for New England and for the South, based on this map. It will be necessary, with the meager knowledge at our disposal, to assume that the whole series of conditions indicated in Fig. 59 will be moved bodily northeastward without change. This assumption does not represent exactly what is likely to happen, but it will simplify the analysis.

As the low moves nearer, winds in New England which have been northeasterly will shift around to the east and then to the southeast. There will be increasing cloudiness and then precipitation, even well ahead of the arrival of the warm front (at ground level). With the arrival of this front, temperatures will rise.

In the center of the country, from the Great Lakes to the Gulf, winds will shift from southwest around to northwest, temperatures will fall with the passing of the cold front, and the weather is likely to be clear and cold. The whole interior may well experience a cold wave which is likely to move on to the East in twenty-four to thirty-six hours.

The above are, of course, decidedly amateurish forecasts and assume ideal conditions. Actually, conditions with regard to the pressure systems may change very swiftly. Direction and rate of movement may change, lows may fill up or highs decrease, or both may become more intense. The above discussion will have served its purpose if it has demonstrated (1) the generalized anatomy of the high and low, (2) the effect of the wind circulation of each on the weather of the territory under its influence, (3) the variation in the weather of any place due to the passage of highs and lows over or near it, and (4) the tremendous number of complications involved in forecasting.

Cyclonic Weather Outside North America. All parts of the prevailing westerly belts in both hemi-

spheres are more or less affected by cyclonic storms whose influence often extends over the edges of the belts in both directions. Indeed, there is considerable evidence that fronts of contact between cold and warm air traveling in opposite directions occur in lower latitudes than the polar front Certainly storms of very similar anatomy to the highs and lows of the prevailing westerlies develop at times in very low latitudes.

Figure 60 is a map showing, in a highly generalized way, common cyclonic storm tracks over the world. In Europe the storms are especially well developed in winter and affect areas as far south as the Mediterranean. Central Eurasia is under the influence of the more or less permanent high of the antimonsoon at this season, and storms tend to swing to the northward and southward of this center. Thus, western, northwestern, and southern Europe are stormier than the eastern interior. In Asia, eastern China and Japan tend to have stormy winters due to cyclonic influence.

In the Southern Hemisphere there is not much land in the prevailing westerly belt, but cyclonic storms are well-developed over the seas There is a band of very stormy conditions, in both summer and winter, in the latitude that has become famous as the "roaring forties." Southern Australia and southern South America come under strong cyclonic influences when the tracks move equatorward in the Southern Hemisphere winter.

QUESTIONS FOR DISCUSSION

1. Forecasts made by the United States Weather Bureau are said to be 80 per cent accurate What factors may cause a given forecast to be incorrect in some measure?
2. What would the winter climate of New York City be like if there were no cyclonic storms?
3. What correlation can you find between Huntington's map of climatic energy (Fig. 8) and the map of world storm tracks (Fig. 60)?

Tornadoes, Hurricanes, and Typhoons. A *tornado,* often erroneously called a "cyclone," is a violent storm of relatively small area which is a not infrequent occurrence in the Mississippi Valley. It is, apparently, the result of violent local convection, and its high wind velocities are due to steep pressure gradients between extremes of temperature in a short distance. Wind velocities may reach five hundred miles per hour for short periods of time, but fortunately the area of devastation is usually less than a mile wide, and the force of the storm is generally dissipated after it has traveled a score or so of miles. The circulation of air into the center and upward is

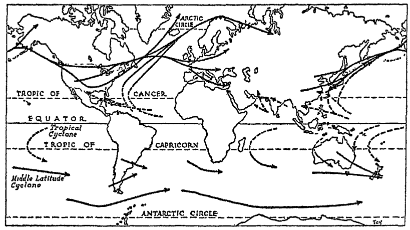


Figure 60. The principal tracks of low pressure areas.

similar to that in a cyclonic low, but much more violent Apparently, the shift from the cold to the warm seasons contributes to the cause of these storms, since they usually occur in the late spring.

The tropical storms of great intensity known as *hurricanes* in the West Indies region and Australia, and as *typhoons* in the China Sea, are usually destructive over a wider area. They travel much farther than the tornado, although wind velocities are seldom as great. They, too, are low-pressure areas and, apparently, are formed on the edges of the trade winds, are carried by these winds roughly westward and then turn poleward. They are not so definitely limited, seasonally, as the tornado but usually occur toward the end of the warmest season, so are, probably, also related to the unstable pressures and temperatures associated with seasonal change.

Thunderstorms. Local storms of small extent, usually associated with erratic wind squalls, sudden and violent rainfall, and thunder and lightning, are called *thunderstorms.* The anatomy and mechanics of such a storm are complex, but certain aspects of them may be simplified to indicate how they differ from other storms, and why they involve electrical discharges. Such storms are common in the tropics, and, in the warmer season, in the middle latitudes, thus indicating that most types are associated with upward currents of air due to convection. The fundamental difference between the thunderstorm and other convectional rains apparently lies in the unusual rapidity of this upward movement of the air. It results in a very high, billowy, dark cloud which is the center of the storm and the visible sign of its approach.

The rapidity of this upward rush of humid air causes it to penetrate to unusual heights and to mix with other air of different temperatures and moisture content, thus resulting in turbulence in the atmosphere over the surface of the earth and in the cloud. As condensation occurs, large drops are formed which

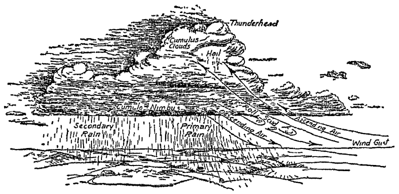


Figure 61. Diagram of a thunderstorm. (Courtesy of A. K. Lobeck)

are torn apart by the violent air movements in the storm, resulting in a condition in which some of the atmosphere is positively charged with static electricity and some of it negatively charged. The lightning flash is but the discharge of electricity from one area to another in the adjustment of this situation. Usually, only a very small percentage of these discharges reach the surface of the earth. Thunder is caused by the explosive expansion of the air due to the heat generated by the lightning.

Thunderstorms are of great economic importance because they contribute much of the summer rainfall in the interior of continents in the middle latitudes. The suddenness with which they form, and the heavy precipitation while they endure, allow for a combination of a large amount of rainfall with a high percentage of possible sunshine—a very favorable condition for plant growth. Most thunderstorms in the middle latitudes are of decidedly local extent and are but moderately violent. Some, however, do great damage because they bring a deluge of rain, high wind velocities, and hail or severe electrical discharges.

The Value of Dependable Weather Forecasts. The advantage of knowing, even twenty-four hours in advance, what the weather is likely to be is tremendous. Great savings in property and of lives at sea, on land, and in the air result from adequate warnings of severe storms and fogs. Flood warnings on the Mississippi River system are, indirectly, a weather-warning service and have repeatedly made it possible to effect similar savings. In fruit-growing regions, frost warnings in late summer and early autumn cause the growers to light smudges in their orchards and prevent, or limit, damage to their crops. Many a farmer is enabled to "make hay while the sun shines" because the Weather Bureau tells him in advance when the sun is likely to shine.

These are the more obvious uses of weather forecasts. There are many uses of this service which are less obvious, and some of them are quite new. Moving-picture companies, for example, make great use of them in planning production schedules in advance, especially for outdoor shots. Engineers in charge of heating large buildings are enabled to prepare in advance for cold waves and to save coal by decreasing steam pressures in advance of warm waves. City authorities may mobilize snow-removal crews and equipment in preparation for severe snowstorms.

Air Mass Analysis. Studies of polar fronts and the development of aviation have led to a marked increase in knowledge of the upper air conditions. It has been observed that great masses of air tend to maintain their characteristics for a long time, even when moving over great distances and over considerable changes in latitude. These masses have been analyzed, not only as to their appearances on the earth's surface, but also as to their height, temperature, pressure, and other characteristics by means of sounding-balloon and airplane observations. As a result of these investigations it has been possible to work out a system of weather forecasting which is more accurate and covers a longer period than possible by mere surface observation of highs and lows.

For example, if cold air in a winter high over central United States comes from the north Pacific, its characteristics will be different from those of a cold mass originating in interior Canada. If warm air blowing into a low is coming from the interior of Mexico, it will be quite different from warm air from the Gulf of Mexico, and its effect on the consequent history of the low will vary accordingly. By observing, mapping, and analyzing such masses, a much more accurate forecast can be made than would be possible if all cold air, or all warm air, were considered uniform. Air mass analysis maps are not yet published for distribution to the general public in the United States, but they are made available to forecasters and especially to aviation weather stations. They form the basis for the cautious weekly forecasts which are now being published in the Sunday editions of some metropolitan newspapers.

QUESTIONS FOR DISCUSSION

1. How might the possibility of occasional tornadoes affect the architecture of a region?
2. How might accurate forecasts of weather for a whole month in advance be of use to state or municipal governments? to transportation companies? to householders? to retail merchants?
3. In September, 1939, at the outbreak of war, most European governments ceased to exchange weather information. Why?

CHAPTER 12

THE NATURE OF SOILS

Almost all food comes from plants—either directly or, indirectly, through animals. The food values in plants are manufactured by them from elements in the surrounding air and soil. These necessary connections between soil, plants, and food have made man, in all ages, a creature whose chief economic concern was the land.

It is apparent that the nature of the soil is of fundamental concern to the farmer who is using it to produce crops, but it is perhaps not so immediately apparent that soil is also of direct interest to other classes of the business community. The nature of the soil in a region not only influences the nature and amount of the crops grown, and therefore the number and prosperity of the farmers, but it also affects the amount and nature of the freight on railroads, the number and prosperity of wholesale and retail outlets, the landholding system, the fortunes of all classes in the community; in fact, the whole organization of the society.

Southampton and Sunderland. The ramifications of the influence of soil when other factors of the environment are similar may be seen in a comparison of Southampton and Sunderland, two exclusively agricultural towns[1] in west-central Massachusetts. Both lie partly in the Connecticut Valley lowland and both have, also, considerable areas of rough land which is suitable only for poor pasture and timber. In the area of land with topography sufficiently level to be suited to crops, they are about equal. Each is equally near markets in near-by manufacturing districts, and each is satisfactorily served with transportation facilities.

Figure 62, however, reveals some important differences in the intensity and value of man's activity in the two. While Southampton is nearly twice as large as Sunderland and has twice as many acres in farms, it has fewer farms, a smaller population, a slightly smaller area in crops, and the value of its land and

Figure 62

A COMPARISON OF SOUTHAMPTON AND SUNDERLAND, MASS.

(from United States Census—1930)

	Southampton	*Sunderland*
Population	931	1,159
Area of town	18,304 acres	9,216 acres
Number of farms	158	172
Land in farms	14,008 acres	6,974 acres
Average size of farms	89 acres	41 acres
Land in crops	2,480 acres	2,780 acres
Value of land and buildings in farms	$997,135	$1,713,250
Average value per acre of land and buildings	$71	$246
Value of machinery and equipment	$75,807	$125,110

buildings is only a little more than half that in Sunderland. The value per acre of the land and buildings in Sunderland is more than three times that in Southampton and the value of farm equipment and machinery is about one and a half times.

All these comparisons indicate that Sunderland is a town in which a larger number of farmers are using small and valuable farms intensively, while Southampton has fewer, but larger, farms of lower value which are used extensively. As has already been pointed out, the area of level or gently rolling land in the two is about equal; so the differences must be based largely on soil. An examination of the soil surveys[2] bears this out fully.

In Southampton, the soils are either an infertile sand or gravel, or a stony loam. In Sunderland, they are silts or sandy loams of very high fertility. Sunderland has large crops of onions, tobacco, and cucumbers, grown on her valuable land with intensive labor. Southampton produces pasture and general feed crops with a greater use of poorer land. Much

[1] A New England town is equivalent to a township or parish in other parts of the United States.

[2] Field Operations of the Bureau of Soils, Maps 1 and 2 United States Department of Agriculture, 1903.

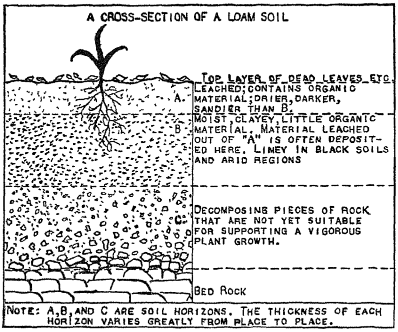


Figure 63.

of her flattest area is such poor sand that it cannot be used for either crops or pasture.

Another effect of rich soil which does not appear in the statistics is that agricultural tenancy (the renting of farm land) is common in Sunderland and almost unknown in Southampton. This arises from the fact that the soils of Sunderland are rich enough to support both tenant and owner and the land is so valuable that only people with considerable capital can afford to buy it. In Southampton the land is cheap and can be bought by people with very little capital. Most of it will not yield enough to support the operator and leave anything over for rent. This tendency for good soil to encourage tenancy and the poorer soil to be almost exclusively owned by the operator is a common phenomenon.

Sunderland has been a town growing in population and prosperity for the last sixty years. In that same time Southampton has declined, slightly, in population. The difference is almost wholly due to the difference in soil.

What Is Soil?

Soil is that portion of the earth's surface in and from which plants are able to grow. To the ordinary observer, soil seems to be nothing more than a mixture of broken and decomposed pieces of rock which might be reproduced by simply grinding rock into small particles. Such an artificially produced mixture would not be soil, and plants would grow but poorly in it, if at all. To the mineral elements of the soil material, there must be added a small, but absolutely essential, proportion of organic matter if it is to become the home of plants and the source of much of their food supply.

Soil Horizons. The fact that soil *grows* and varies according to its age and the conditions of its growth may be seen in a typical cross section of soil as in Fig. 63. It will be observed that, near the bottom, the material is usually similar to the underlying rock or to the boulders in the soil. As the surface is approached, the soil changes in color, size of particles, and chemical composition. Often, the surface layers are so different from the underlying material that it seems incredible that both came from the same rock. Soil scientists generally divide the soil into layers, called *horizons,* as in Fig. 63. The characteristics of these layers vary greatly according to the age of the soil, climatic conditions, vegetation cover, and the methods of cultivation which have prevailed.

In the A horizon, the soil is usually darker than in the B horizon because the humus, or organic matter, is usually confined to the zone near the surface where the plants may more easily get air and water and sunshine. Here the soil is most mature—that is, it is furthest in nature from the original rock material. The A horizon is seldom more than a foot in thickness and usually less. Often, some of the soluble mineral materials have been washed out of the soil in this horizon and carried downward by rain water as it soaks into the soil This is known as *leaching* and is a very important cause of deterioration in soils.

The B horizon is usually deficient in humus, but often abundantly supplied with mineral material—including that leached out of the layer above. Some old soils having an A horizon deficient in mineral elements may be enriched by deep plowing which mixes some of these leached elements back into the upper zone.

Residual and Transported Soils. The cross section discussed above and shown in Fig. 63 is applicable only to soils which are formed *in place* from the underlying rocks. These are *residual soils.* Some soils are derived from materials which have been transported, sorted, and deposited by water, glaciers, or wind These are *transported soils.* In these, the size of the particles may not vary between the A and B Horizons, but if soil processes have gone on unchecked for a considerable period of time, the other differences between the horizons are usually just as fully developed. In other words, the upper layer adjusts itself to its environment, regardless of its origin. A soil which has become adjusted in this way is referred to as a *mature* soil.

QUESTIONS FOR DISCUSSION

1. What are some of the problems of local government in a town with poor soil that is constantly losing in competition with richer land elsewhere?
2. How may each of the following be affected by the nature of the soil in their vicinity: a retail grocer, a hardware and farm-implement dealer, a doctor, a banker, an insurance agent?
3. Is heavy rainfall a good thing for soils? Would a heavy snowfall have the same effect on soils as the equivalent rainfall?

Soil Qualities

Physical Structure. The size of the particles of which the soil is composed largely determines its physical structure. This is very important because the physical structure determines the rate of circulation of air and water through the soil and the ease with which roots may penetrate it. Soils made up of very fine particles closely packed together (as is common in clay) permit only the very slow circulation of air and water, and plant roots penetrate them with difficulty. Such soils do, however, prevent excessively rapid leaching and tend to hold plant foods better.

In soils with very large particles (such as gravels), the circulation of water is so rapid that plant-feeding minerals are rapidly leached out. Rapid air circulation tends to warm such soils earlier in the spring, but they dry out very rapidly and are often subject to drought when finer soils, receiving the same rainfall, would retain their moisture. Sand and silt are both usually larger in their constituent particles than clay, but smaller than gravel.

The relative proportion of the various sizes of soil particles is known as the soil's *texture* [1] The ideal texture is found in a *loam,* which is a mixture of clay, silt, sand, and organic material. A loam contains

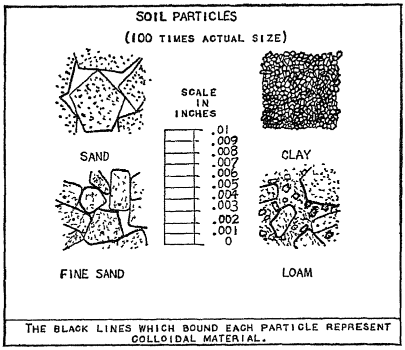


Figure 64

enough large particles so as to provide a satisfactory circulation of air and water, but enough small particles so that the circulation is not too rapid. The smaller particles also act to hold the plant foods in the soil. There are many types of loam, such as *sandy* loam, *clayey* loam, *gravelly* loam, *stony* loam, or *silt* loam, depending on the size and nature of the particles which predominate.

Soils of similar texture may differ in *structure,* that is, in the arrangement of the soil particles within the soil mass Thus fine clay particles may be arranged in groups with air spaces between each group. Such a soil may have the physical characteristics of loam although it is almost all clay. A good structure of this type may result from the presence of humus or lime within the soil. Hence the leaching of lime from a soil may injure its structure and in addition remove the alkalis which prevent soil acidity.

If the physical condition of a soil is poor, it may often be improved. Plowing tends to break up a compact soil and provide air space. The addition of manure tends to prevent caking in clayey soils and to prevent loss of water in sandy soils. The addition of lime to a clayey soil lessens the cohesive qualities of the clay particles Earthworms, moles, and other burrowing animals also play a part in improving the physical structure. It is apparent that any worthwhile, artificial improvement of the physical structure of a soil requires a considerable expenditure of time, labor, and capital and is profitable only under the most advantageous economic conditions and for small areas. It is usually more economical to fertilize soil of good structure, though infertile, than to at-

[1] A typical percentage distribution of materials by size in the soils mentioned above is as follows

MECHANICAL ANALYSES OF SANDY, LOAMY, AND CLAYEY SOILS

	Sandy soil per cent	*Loamy soil* per cent	*Clayey soil* per cent
Fine gravel	2	2	1
Coarse sand	15	5	3
Medium sand	23	5	2
Fine sand	37	15	8
Very fine sand	11	17	8
Silt	7	40	36
Clay	5	16	42

M. Whitney, *The Use of Soils East of the Great Plains Region,* United States Department of Agriculture, Bureau of Soils, Bulletin 78, p. 12. Washington, 1911.

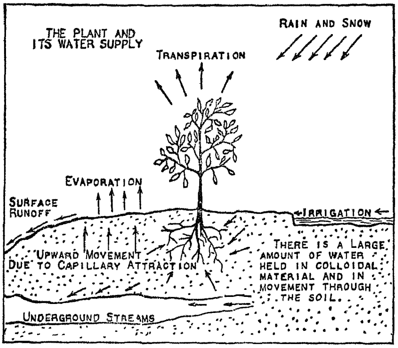


Figure 65

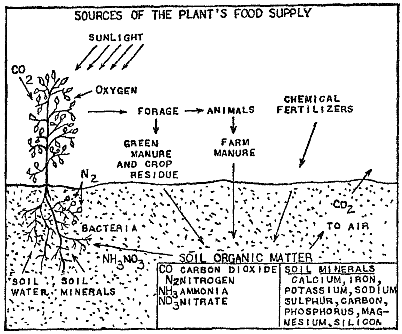


Figure 66.

tempt to improve the faulty structure of a fertile soil.

Soil Temperature. For root growth, a soil temperature of at least 40° F. is necessary. This temperature cannot, however, be determined by the temperature of the air above the soil. Often, the soil remains frozen or cold long after the air temperatures have become warm. Wet soils, especially, tend to remain cold. On the other hand, cultivation and the addition of manure may warm up the soil very rapidly in the spring. During the winter, the soil temperature often remains above the air temperature, especially if the ground is covered with a layer of leaves or snow.

The soil temperature not only controls the growth of plant roots, but it also influences the chemical action within the soil. High soil temperatures speed up the decomposition of organic matter and of the solid soil particles. Conversely, low temperatures retard bacterial, physical, and chemical action.

Ventilation, or Aeration. Closely allied to structure is the need of the plant's roots for fresh air. In general, if a soil has a good structure, air circulates freely enough and aeration presents few problems. One of the objects of cultivation is to loosen the soil so that both air and water circulate freely about the roots. If water stands in the soil, it prevents the circulation of air and may make the soil *acid* (or "sour"), with a harmful effect on both the amount and nature of plant growth.

Water Supply. The need of plants for water is easily understood when it is recalled that water is the largest single element in most green plants. Since this water is obtained through the roots, the need for a good "soil water system" is obvious. Figure 65 shows the main aspects of water circulation in and about the soil. Among the problems involved are the prevention of soil erosion in regions having steep slopes and the avoidance of plant drowning and the formation of sour soils in low-lying regions. In humid regions, the superabundant water supply may wash out most of the plant nutrients from the soil; while, in arid regions, farmers struggle continuously to prevent excessive evaporation from the surface soil. Everywhere, it is important to keep up at least a slow circulation of water to distribute plant foods and to flush out accumulations of poisons generated by plant roots and decaying matter.

The amount of water consumed by plants is enormous. An acre of oak trees transpires over 2000 gallons per day. To produce a pound of hay requires 375 pounds of water. If the necessary amounts of water are not normally available in the soil, the farmer must resort to irrigation or dry farming.

Soil Life. Soils contain innumerable small living organisms, some of which harm, but more of which aid, plant life. These organisms have numerous functions—such as assisting in the decomposition of insoluble organic and inorganic matter. So important are they that, if a soil were baked in an oven until all of its bacteria were dead, it would remain infertile until new and healthy bacteria had time to grow and do their work. Among the most important of these are the nitrogen-fixing bacteria. They attach themselves to the roots of leguminous plants—such as beans, peas, and clover—and, when so attached, have the ability to transform the nitrogen in the soil air into

nitrates which can be used as plant foods. Legumes are, therefore, frequently planted in crop rotations as *green manures* to aid in the restoration of soil nitrogen.

The Food Supply of Plants. Plants obtain some of their food supply from the air, but an important part of it consists of water and minerals from the soil. The plant cannot, however, obtain its food directly from the solid rock particles, but usually gets it from a thin film of colloidal material which develops around each soil particle. (A *colloid* is a jellylike substance containing diverse elements.) Some of the soil material is dissolved in the colloidal substance through chemical and bacteriological action and, thus, puts the food in a form in which it is available to plants. The rate at which this process goes on varies from one soil to another and, in the same soil, from time to time, depending on the physical, chemical, and bacteriological condition of the soil, the climate, fertilizers used, water supply, and system of cultivation practiced.

Under natural conditions, independent of any interference by man, there tends to be an adjustment of the plant growth, with its demand for plant food, to the rate at which that food is manufactured by the soil life and becomes available. Under these conditions, while there is some loss of soil chemicals to the air as gasses and through leaching, most of the elements are returned to the soil as the plants, or the animals which feed upon them, die and decay.

Man Upsets the Balance of Nature. When man begins to grow crops, he usually breaks this locally closed circle through which plant foods travel. He harvests the crop from the field and carries it away. It is consumed by men and animals far from the field where it is grown and the resultant wastes and products of decomposition are usually not returned to the field. In so far as he feeds the crops to animals, locally, and returns their manure to the field as fertilizer, he cuts down this drain, but only in part.

In parts of China, Japan, and Java where a crowded population must continue over a long period of years to get the maximum sustenance from the soil, these human wastes are returned and everything possible is done to keep from breaking the local circle of conservation of plant foods. In the Western World, with its commercial agriculture which often involves the complete removal of the whole plant from the land each year and its consumption thousands of miles from the region of its production, man allows his sewage, rich in soil nutrients, to go to waste. This so badly upsets the soil-plant-animal-soil cycle that the problem of maintaining soil fertility becomes increasingly important as the years go on.

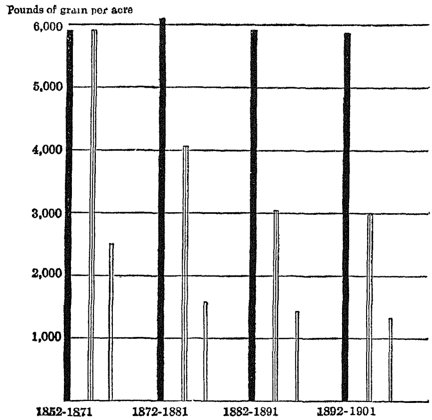


Figure 67 Effects of barnyard manure on the yield of barley. The solid bar represents the yield on fields manured every year. The triple-lined bars represent the yields in fields that were manured until 1871 but not since The thin bars represent the yields in fields unmanured since 1852 (From G. F Warren, *Elements of Agriculture,* by permission of the Macmillan Company, publishers)

Soil Exhaustion and Some Remedies. The colloidal material contains the various elements needed by the plant (usually they are carbon, hydrogen, nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron). Unfortunately, these elements are not often present in exactly the proportions needed. At first, this makes little difference, as a surplus of all elements is usually present in a virgin soil, but after several crops have been harvested, it may appear that the available supply of some of these elements has been reduced so greatly that the plants have difficulty in obtaining adequate quantities. Nitrogen, phosphorus, calcium, and potassium are most likely to be used up and, therefore, most attempts at fertilization are concerned with the replacement of these elements. Two of these—calcium and potassium—are often leached out by the circulation of water and such leaching (common in humid regions) creates an unhealthy condition known as soil *acidity*.

When partial or total exhaustion occurs, the soil may recover if it is allowed to *lie fallow* (uncropped) for a year or more. This was a common practice in medieval Europe and is still very important. It is obvious that such a practice is difficult in a crowded

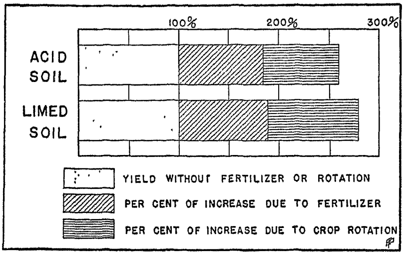


Figure 68.

region where every acre must be used to its utmost. During the fallow period, the soil particles decompose further and chemical solution and bacterial action add to the colloidal material and, thus, replenish some of the exhausted elements.

The addition of fertilizer is a more rapid way of feeding the soil. The missing elements may be applied either as chemicals (ammonium sulphate, calcium oxide, sodium—or potassium nitrate, and phosphates are commonly used), as farm manure, or in the form of fresh mud.[1] The manures are considered superior to the chemicals in most cases since they replace almost all of the elements extracted by the plants and also supply organic material.

Soil exhaustion may be retarded by the use of *crop rotation*. This practice is based on two facts: (1) the amount of each element extracted from the soil varies with each kind of plant; (2) some plants, especially if the stalks and foliage are plowed back into the soil, add certain elements which are needed by other plants. A typical rotation consists of planting in succession in the same field: corn, wheat, clover, and hay. Figure 68 shows that crop rotation may do as much to increase crop yields as the addition of fertilizer. It also shows that an acid soil (probably a compact clay) is less sensitive to both fertilizer and crop rotation than the same soil with its acidity corrected.

The Soil Is Like a Bank Account. It may contribute to an understanding of the processes of maintaining soil fertility—and, therefore, agricultural yield—if the soil is regarded as a bank account. The account yields income which varies with the amount of capital and the rate of interest. The capital in the soil is its fundamental quality and the rate at which the soil manufactures plant foods is the rate of interest. In neither the soil nor the bank account is it possible to take more than interest from the account without depleting the capital. Depleted capital means reduction in yield. In the case of depleted capital, either the soil or the bank account may be allowed to "lie fallow" until the capital is restored and the old rate of interest may be resumed. The analogy is not perfect, but it contributes to an understanding of the situation.

Tenancy and Soil Exhaustion. Short-term farm tenancy often results in soil depletion because the tenant is primarily interested in getting the greatest immediate yield. To offset this, leases sometimes require the use of crop rotation or the application of fertilizer.

QUESTIONS FOR DISCUSSION

1. How may the physical structure of a soil be improved?
2. Why is animal manure generally considered superior to chemical fertilizers?
3. Under what economic conditions is soil likely to be allowed to lie fallow? In many countries it is considered economically advantageous to use large quantities of fertilizer rather than practice crop rotation. Why?
4. What physical factors limit the amount of desert land available for irrigation? Compare dry farming and irrigation as to physical requirements, intensity of utilization, and labor.

The Geography of Soils

The farmer and the geographer need to know at least three things about the soil of a specific area: (1) For what crops it is suited, (2) how productive it is of each crop, and (3) how cheaply the soil's fertility can be maintained or improved. For most parts of the world it is not easy to obtain accurate, detailed information on these points Many statements about soils are found in regional descriptions, but in many cases they are based on superficial observation and incorrect deduction. For example, the superficial observer sees the luxuriant vegetation of the tropical rainforest and deduces that the soil must be rich. Actually, as has been shown by experience, the soil deteriorates rapidly once the original cover is removed, and the rankness of the vegetation is caused by the constant humid heat rather than by the soil's fertility. The only really accurate, detailed data come from

[1] Within recent years methods have been devised by which plants can be grown successfully without soil. One method is to plant the seeds in a bed of damp sawdust which is held by a net above a tank of water. The water is mixed with the same chemicals which the plant would normally take from the soil. The seeds germinate in the sawdust and send their roots into the weak chemical solution beneath. Flowers and vegetables grown by such methods have been better in quality and of a larger yield than those grown by ordinary farming Although soilless agriculture is being used commercially in California and France, it does not yet produce an important share of any crop. Its implications, however, are revolutionary.

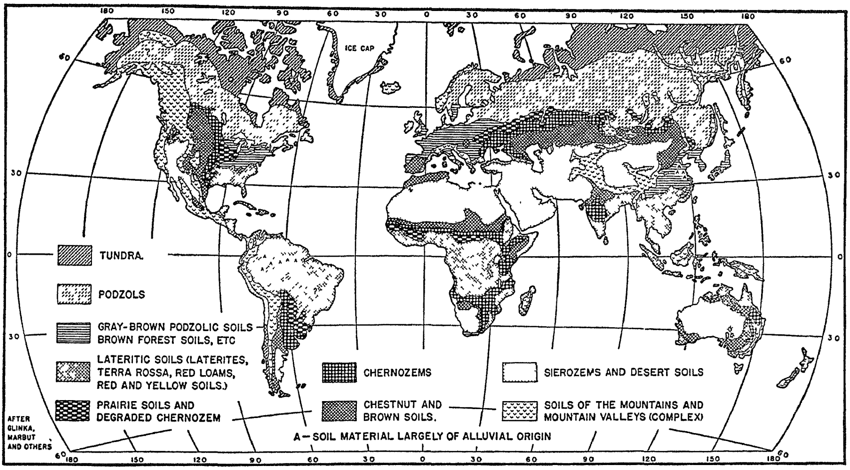


Figure 69. A generalized world map of soils. These major soil groups are closely associated with the climatic regions and will be described under the appropriate regions. The map is on the Van der Grinten projection (p. 32). (From *Soils and Men, Yearbook of Agriculture, 1938,* U. S. D A)

scientific soil surveys and long farming experience.

Figure 69 shows how the soils of the world may be divided into broad groups. The distribution of each group is controlled largely by climate, and so is usually regular all over the world. Hence if a soil has lain undisturbed for a long period in a given environment, it acquires certain typical properties almost irrespective of the nature of the rock from which it was derived.

The correlation of the major soil groups with specific types of climate will be considered in the two subsequent chapters. The balance of this chapter will outline the usual effects of the principal influences on soil formation. The manifold combinations of these influences explain why soils vary greatly from field to field as well as from region to region.

Parent Material. It was formerly believed that underlying rock was the principal determinant of the nature of soils. Limestone, volcanic rock, loess, and alluvium were known to produce more fertile soil than sandstone, quartzite, slate, and schist. The influence of the parent material is especially important in young soils. Mature and old soils, modern soil scientists point out, contain only a small percentage of the minerals found in the parent rock; the remainder has been washed away by the rainfall of centuries. Hence, in soil formation, the environment and the cultivation of the soils are more important than the parent material, although the influence of that material is rarely negligible.

Moisture. The most fertile soils are often found in areas too dry for cultivation, because a large amount of water in soil causes erosion and leaching, especially of such soluble minerals as lime and potash, where removal—since they neutralize the acidity caused by decaying organic material—results in the development of an acid soil.

Temperature. In general, the speed of chemical reactions doubles for each rise of 18° F. Thus high temperatures encourage the disintegration and decomposition of solid soil particles, thereby increasing the amount of available nutrients. Freezing temperatures practically stop such action.

Unfortunately in many tropical areas the rapid decomposition of soil particles is accompanied by a thorough leaching which offsets the beneficial effects of rapid chemical reactions. In cold regions leaching is retarded throughout much of the year by the frozen condition of the soil. Areas with hot summers and cold winters have the advantage of rapid decomposition during the growing season and frozen soils during the dormant season.

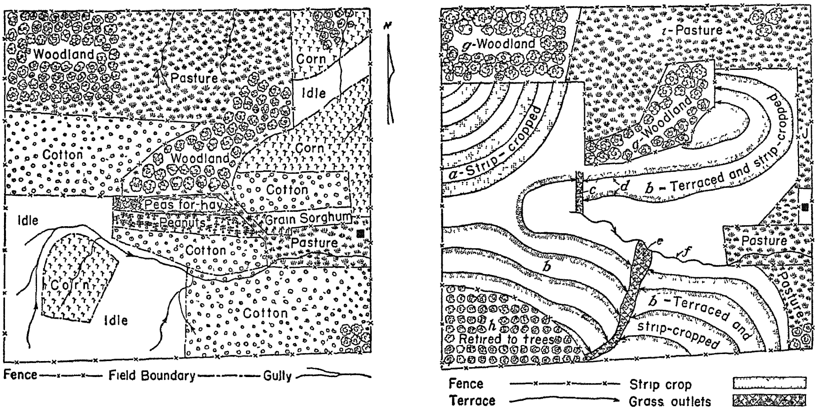


Figure 70. Two diagrams of a farm located on the upper coastal plain of the South. The farm consisted of a number of small, irregularly shaped fields, some of which were only 3 or 4 acres in size Gullies had appeared and destroyed about 12 acres of land. No definite crop rotation was being used The diagram to the right shows this farm after the fields had been rearranged according to the suggestions of the Soil Conservation Service. (From *Soil Defense in the South,* Farmers' Bulletin No. 1809, U. S. D. A.)

Wind. Natural vegetation protects soil from wind erosion except in desert areas where plant cover is sparse or lacking. Here the wind removes the lighter soil particles and leaves a residue of sand and pebbles. When farmers remove the natural grass cover from semiarid regions, as in northwestern Texas, wind erosion becomes serious unless the soil is well anchored by crops.

Relief. Soils on steep slopes are often washed away by surface erosion—especially if they are cultivated and left unprotected by trees or grass. Even if the bedrock is not denuded, the A and B horizons may be washed away. The remaining soil is generally shallow, stony, and infertile.

Lowland soils often suffer from poor drainage and become sour and water-logged. Even if conditions are not swampy, these soils may dry out and warm up slowly in the spring Consequently soils on very gentle slopes have as a rule the most satisfactory relief.

Vegetation. The flora influences soil through the debris it deposits, through the minerals it removes, and through the action of its roots. Grasses hold the soil cover firmly in place, and their decaying roots and stalks add humus; thus, unless the grass is removed by man or animals, grasses benefit the soil without impairing it. Trees send their roots far into the subsoil and bring water and minerals to the surface. The leaves they deposit on the forest floor protect the soil against erosion but also form acids which hasten decomposition and leaching. In general, natural grasslands are associated with better soils than forest areas.

QUESTIONS FOR DISCUSSION

1. Find out what you can about the soils in your county. How varied are they? Can you explain the variations?
2. How does cultivation influence the nature of a soil? Is it a good policy to leave cleared land uncultivated?
3. Is there any adjustment to soil conditions in the fact that grazing and the raising of tree crops are common activities in mountainous regions?

CHAPTER 13

CLIMATIC REGIONS OF THE WORLD: TROPICAL AND SUBTROPICAL

CLIMATE plays such an important part in determining the nature of the various parts of the earth's surface that a division of the earth into climatic regions affords a good introduction to the several types of environment. Climate determines the natural vegetation, and strongly influences the nature of the soil. Likewise it exerts an important influence upon the distribution of men and their activities.

Tropical Climates. The term *tropical* arises from the position of these climates between the tropics of Cancer and Capricorn, the two parallels of latitude which mark the northern and southern limits of the vertical rays of the sun. The fact that the sun's rays at noon are never far from vertical prevents any marked seasonal variation in temperature Often the diurnal variations in temperature are much greater than the seasonal ones. Seasonal changes in precipitation rather than in temperature are, therefore, the significant basis for climatic classification in the tropics.

Except in high altitudes, the tropics are frost-free and usually have temperatures too high to be stimulating to people of the United States and northwestern Europe. However, it is the *monotony* of the continuously warm weather which is debilitating, for much of the United States has summer temperatures which equal or exceed tropical heat. Aside from these few generalizations (and many important consequences which follow from them), the differences between various parts of the tropics are more striking than the similarities.

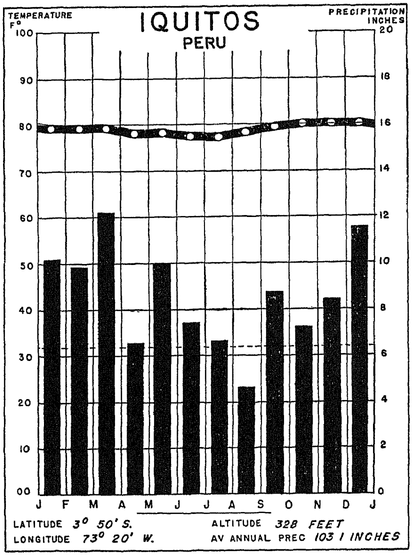


Figure 71. A typical station in the tropical rainforest climatic region (1). In this and similar charts, the vertical columns represent the average precipitation for each month. The heavy line toward the top indicates the average temperature for each month.

The Tropical Rainforest

This climate (1 in Fig. 72) is set off from other tropical climates by its continual dampness. Figure 71 shows in graphic form the climatic data for this climatic type. There is no distinctly *dry* season—merely a *less rainy* one. The rainfall, which is almost entirely of the convectional type resulting from the rising columns of air in the doldrums, usually falls in heavy showers which are an almost daily occurrence. Throughout the region both the absolute and relative humidities are almost always very high.

The average monthly temperature is fairly constant throughout the year. The average for the year is close to 80°, and the monthly average does not vary more than two or three degrees from the yearly mean. Temperatures during the heat of the day range from 90° to 95° F. while just before dawn the temperature may drop to nearly 70°.

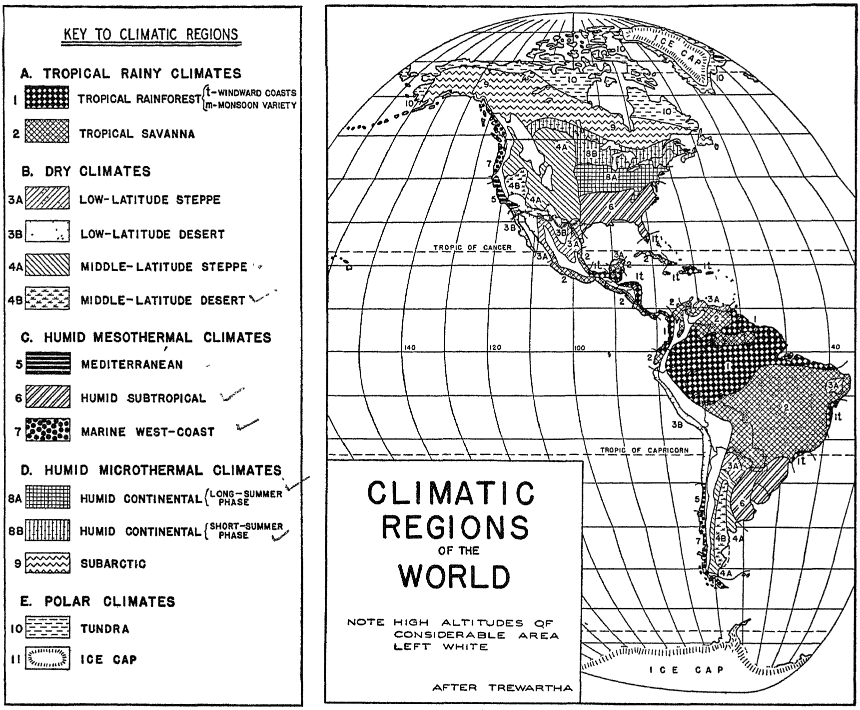
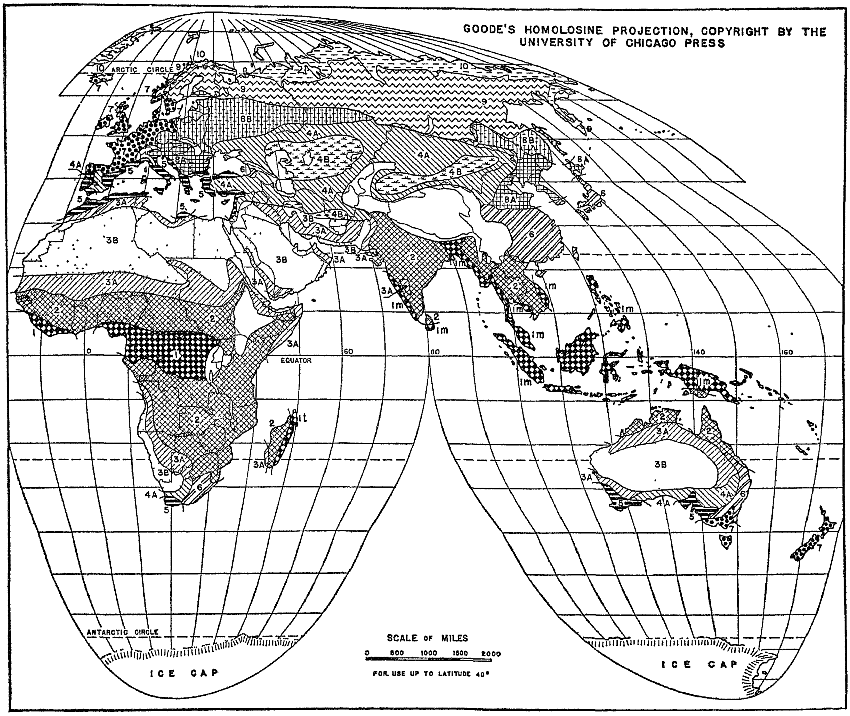


Figure 72. The climatic-region map, the relief map, and the population map are probably the most valuable world maps for the study of geography. Every student should be thoroughly familiar with the main features on these maps.

The tropical rainforest climate extends around the earth wherever the doldrum rains occur practically throughout the year. The largest areas with this climate are in the Amazon Valley of South America and the Congo Valley of Africa. In addition, in tropical regions where mountainous coasts face the trade winds, continuously hot, humid conditions similar to those in the doldrums arise. This explains the inclusion of the trade-wind shores in the West Indies and Central America, on the northeastern and eastern coasts of South America, and on the coast of Madagascar in the Indian Ocean. Where this type of climate has a marked trade-wind influence, it is classified as "1^{t}" in Fig. 72.

The summer monsoon, drawing moist air from the Indian Ocean onto the southwestern coast of India, adds to the rainfall there and results in its inclusion in this type. The Malay Peninsula and many of the islands of the East Indies are under the influence of the monsoon or antimonsoon throughout most of the year. During the summer, the monsoon blowing toward the low over Asia brings rain to the southern parts of these areas. In winter, the antimonsoon brings additional rain to the northern parts. There is usually sufficient rainfall at all seasons so that there is no marked period of dryness, and plant growth is continuous. Where there is a marked monsoon or antimonsoon influence in this type of climate, the region is designated as "1^{m}" in Fig. 72.

Flora. The constantly high temperatures and the heavy, well-distributed rainfall result in optimum atmospheric conditions for plant growth. Thus, al-



The regions shown are those laid out by Glenn T. Trewartha They are a modification and a simplication of the more mathematical climatic regions of Koppen. The letters A-E represent the principal climatic groups in the Koppen system.

though the soils are often infertile, a luxuriant mass of richly varied evergreen vegetation grows throughout the year. The most conspicuous feature of this forest is the tallness of the broad-leafed trees which rise to over 100 feet, and form a dense canopy of foliage which shuts out the sunlight from the forest floor. An understory of smaller trees, climbing vines, and parasitic plants is common, but there is inadequate light to support a dense undergrowth.

Along rivers and seacoasts, the sunlight is able to penetrate to the forest floor, and an area with thick, impenetrable undergrowth results which is known as *jungle*. Such jungle conditions are also common where the land has been cleared for farming, and later abandoned.

Fauna. Large animals are scarce in most tropical forests and, except for the water buffalo and the elephant, animals that aid man in his work are lacking. On the other hand, there are numerous small forms of animal life that handicap human activities: mosquitoes, flies, and cockroaches that carry disease; ants and termites that ruin houses and crops; beetles and worms that injure the crops; and venomous snakes, spiders, and scorpions.

Soils. Tropical rainforest soils are generally infertile because the warmth and humidity encourage the rapid decomposition of soil particles. The wealth of plant nutrients thus formed is not long available for the heavy rains soon leach them from the soil. Even the silica dioxide (the most common ingredient of

sand) is often leached out and fine, insoluble particles of iron or aluminum oxides are all that remain. These form a compact clay known as a *laterite* (from the Latin word, *later,* meaning brick or tile) because of their characteristic reddish color. Laterites are inadequately supplied with most plant nutrients and with humus. Whatever organic materials have accumulated in these soils while under the forest canopy are usually leached out shortly after the land has been cleared.

Fortunately not all tropical rainforest soils are as little worth cultivating as the mature laterites. The more productive areas have young soils whose fertility has not yet been leached out. These soils fall into four classes: (1) volcanic soils, (2) limestone soils, (3) delta and alluvial soils, (4) some hillside soils.

The volcanic soils consist of recently decomposed lavas and ashes. Since this material has been erupted from beneath the earth's crust, it has not been subjected to as long leaching as sedimentary rocks and therefore still retains a large part of its minerals. The coffee area of Brazil and the sugar fields of Java and Hawaii are among the productive areas whose fertility is based on volcanic soils.

The limestone soils contain so much valuable plant food that it is difficult to destroy them unless the entire soil is removed. The high lime content keeps the soil in good physical condition and thus overcomes the common tropical handicap of poor structure. The sugar soils of Cuba are largely in this class.

The materials washed out of tropical soils are carried by streams toward the ocean Often these streams flood adjacent lands or form deltas at their mouths. In either case the muds they deposit are likely to be rich in plant foods and very productive if they can be properly drained. The banana plantations of Central America usually are found on soils of this type.

On level lands the leached soils tend to stay in place, but on tropical hillsides the leached top layer may be washed away and new, rich soil material may be exposed underneath. This material, in turn, may be washed away, but if tree crops are used this erosion may be slowed down. Since tree crops make up a large part of tropical agriculture, hillsides play a more important part in tropical regions than in the temperate zones.

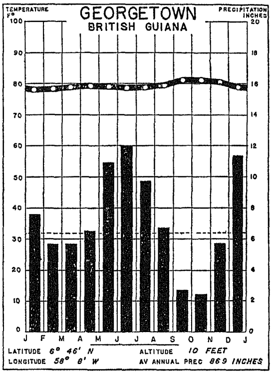
Topography. The heavy rainfall and the rapid decomposition of the soil and rocks cause a fast topographic aging of the surface. The lands are intersected by a multitude of streams and rivers whose waters are muddy and stained by the humus leached from the forest floor. Broad flood plains, often swampy during the rainier season, are common along the main streams. Erosion is so rapid that, except where especially resistant rocks such as sandstone prevail, the land is leveled upstream almost to the headwaters In hilly lands the forest cover protects the hillsides for a time but cleared, unprotected slopes are soon eroded.

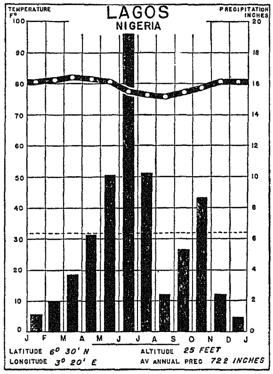
Economic Development. Unhealthy conditions, an unstimulating climate, poor soil, the rapid growth of weeds, a scarcity of large domestic animals, and a difficult labor problem have combined to retard the economic development of the tropical rainforest. Thus many primitive groups have been able to survive in the Amazon Valley, in central Africa, and in the interior of some of the East Indies. These small, isolated groups of peoples possess only a few implements and weapons, and obtain their living by hunting, fishing, and gathering the fruits of the forest. They live in easily constructed huts and move to a new locality whenever there is a shortage of game or other food in their neighborhood.

Throughout the tropical forest there exist groups of primitive farmers. Their usual method is to cut down a section of forest, burn the brush, and then plant a garden between the stumps. The garden usually has a variety of crops—bananas, beans, yams, etc.—which are planted haphazardly throughout the garden space. After a few years the soil is thoroughly leached by the rain and the crop yields decline. When this happens, the farmers cut down a new strip of forest and desert the old fields. This type of agriculture is called *nomadic agriculture* because of the frequent shifting of the garden area.

In southeastern Asia and the adjacent East Indies, *plow agriculture* is the dominant occupation. The plow and domestic animals were introduced into this area from China and India. Agriculture is much more stable here than in the forests of Africa: the lands are cleared for permanent farming, drained, and carefully fertilized. Rice for home consumption is usually the chief crop, although sugar and other crops for the world market often form part of a crop rotation. Plow agriculture is usually associated with an organized government and a moderate amount of trade.

The problems of the tropical rainforest are so great that the resources of large-scale business organizations have usually been necessary to solve them. European and American capitalists have invaded the more easily accessible parts of the forest, selected the areas of fertile soil, improved local sanitary conditions, and established plantations. Usually these plantations concentrate on the production of one or two crops, and import most of the food and supplies needed. Because they are dependent on one crop, they suffer from





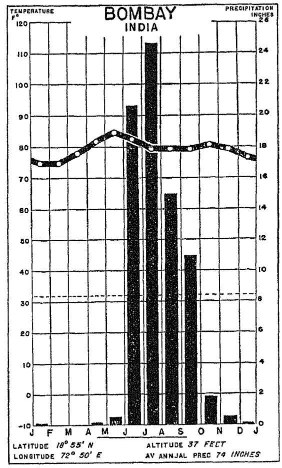


Figure 73. Georgetown is a tropical rainforest station influenced part of the year by the trade winds. Lagos also shows trade wind influence and some monsoon influence. Notice that in both the Georgetown and the Lagos charts there is a drop in actual temperature accompanying the heaviest rainfall. The sensible temperature, however, may be quite high because of the high relative humidity Bombay, on the edge of the tropical-savanna region, shows the results of very strong monsoon influence. At this station temperatures rise as the heat of the sun grows stronger between February and May. Increasing temperatures and little rainfall result in increasingly drier conditions. Vegetation is parched and dust fills the air When the monsoon "bursts" in June, actual temperatures drop considerably and, although the humidity rises, the rainy season is more comfortable than the preceding one The pleasantest time of year is that of the retreating monsoon when temperatures are relatively low and humidity is decreasing.

many of the handicaps of one-crop agriculture: soil exhaustion, danger of crop failure, and dependence on a distant market. The inefficient labor supply is another handicap which prevents the development of plantations in many parts of the tropics which are otherwise well suited for cultivation.

In spite of the difficulties of tropical plantation agriculture, these plantations produce a surprising number of major commodities, including rubber, sugar, cacao, bananas, pineapples, pepper and other spices. Many of these products were formerly gathered from wild plants, but are now produced more cheaply by cultivation. Many gums, oil seeds, nuts, drugs, and dyestuffs are still collected from the tropical forest for export to world markets, but, as the demand for each of these increases, it is likely that many more will be produced on plantations.

The timber and mineral resources of the tropical rainforest have remained almost unexploited because similar materials were more easily obtainable elsewhere. Tropical lumber is not generally exploited because of the impenetrability of the forest, the lack of good labor, and the scarcity of marketable trees. Certain valuable woods, such as mahogany, teak, ebony and cedar, are exceptions. Minerals are exploited only when the price is high enough to justify the high costs of building railway lines and recruiting labor forces. As the more easily worked temperate deposits become exhausted, tropical deposits will undoubtedly be more completely utilized.

The Tropical Savanna

This climatic region (2 in Fig. 72) differs from the tropical rainforest in that it has a very hot dry season of sufficient length to affect the vegetation. This prevents the growth of some plants, and gives a seasonal rhythm to many of the others. Not only is the total rainfall less than in the adjacent tropical rainforest but it is less dependable. Thus seasonal and annual drought is a major problem in this region.

Why the dry season? The most important reason is the shift of the wind belts. In the rainforest, the doldrums with their convectional rains are present *throughout* the year; in the tropical savanna the doldrums are present *most* of the year. During the winter season when the wind belts move with the apparent movement of the sun, the trade winds replace the doldrums. These are drying winds (see page 78) which bring hot, dry weather.

In a few places, the dry season is due to the formation of rain shadows or to special local wind conditions. For example, a large part of the East African Plateau might be expected to have a tropical rainforest climate because of its position astride the equator. However, the Southern Hemisphere trade winds blow unusually far north here during June, July, and August when the Indian monsoon disrupts the normal formation of the doldrums over the Indian Ocean. These trade winds, combined with the relatively cool temperatures due to the altitude of the plateau, discourage convection and thus cause a dry season in a latitude usually rainy throughout the year.

In some places, especially in Asia, trade winds would cause deserts if no other influence intervened. The monsoon, however, brings heavy summer rains which make the annual rainfall equal to that of the tropical-savanna areas nearer the equator. Such monsoon areas are similar to other tropical-savanna regions in respect to most influences on plant and animal life. The most significant differences are the more abrupt seasonal changes, the shorter (but no less rainy) wet season, and the cooler winter weather in the monsoon areas. The weather of India, so well known because of its frequent description in literature, is of this type.

The transition between adjacent climatic regions is rarely abrupt. Many stations will be found whose weather records show the characteristics of two climatic types. For example, eastern Cuba is classified as "1^t" on Fig. 72 while western Cuba is included in the tropical savanna. But western Cuba does not have a *dry* season which is the usual characteristic of the tropical savanna. It does have a *less rainy* season and its total annual rainfall is inadequate to support the tropical rainforest flora, hence it is classified as tropical savanna. Eastern Cuba with a heavier rainfall is included in the tropical rainforest. This illustrates the sort of arbitrary decision which is so often necessary in making climatic classifications.

Flora. The transitional nature of the tropical savanna is well illustrated by its flora. Adjacent to the rainforest, trees predominate but they are deciduous rather than evergreen, and shed their leaves during the dry season. The roots of the trees must spread out laterally to obtain adequate moisture, hence the trees are less closely spaced than in the rainforest. The forest continues to become more open as the drier part of the savanna is approached. In the driest areas, trees are either lacking or limited to banks of streams, or only scrub and thorn forest appear.

The forest is sufficiently open to permit the growth of grass on the forest floor. As the trees become more widely spaced, the grass becomes more important and in the driest areas often displaces the trees. The most usual savanna formation, known as parkland, consists of trees bunched together near streams and in moist depressions but elsewhere scattered sparsely through the grassland.

Seasonal change is the most striking aspect of the vegetation. With the advent of the rainy season, the trees bud and put out leaves and blossoms. The grasses change from a burnt yellowish-brown to a verdant green, and grow with marvelous rapidity. Were it not for the hot, sticky weather, the countryside might remind the visitor of the temperate-zone spring.

Fauna. The savanna is the home of the larger animals of the tropics. The herbivorous animals such as antelopes and zebras are the common prey of the carnivorous lions, tigers, or jaguars. But this fauna seems doomed by the hunter's rifle to almost complete extinction and replacement by herds of domestic animals.

Soils. The soils are usually less leached and hence more productive than the laterites of the tropical rainforest. In the moister areas, the soils are reddish and, although of low fertility, are often worth improving by fertilization because of their good structure. In the grassland areas, the soils (tropical chernozems and prairie soils [1]) are darker and more fertile. Unfortunately these soils are difficult to work because they are soft and sticky whenever there is sufficient moisture for agriculture.

Topography. The alternating wet and dry seasons cause a corresponding alternation in the flow of the streams. Many of the smaller streams disappear in the dry season, and the large rivers are unable to carry their load of mud, which forms numerous bars and alluvial flats in their channels. The beginning of the rainy season finds the sun-baked soil poorly protected by the dried-up plant cover, and a rapid runoff with severe erosion occurs. Soon after the rivers rise, overflow their banks, and flood the adjacent countryside. This produces extensive marshes which are breeding places for insects and disease. Erosion is rapid but not so much so as in the rainforest. Rounded hills interspersed with broad flood plains and deltas are the most common relief forms.

Economic Development. Primitive peoples in these regions commonly make their living by hunting, seed collecting, and herding. Farming is difficult with-

[1] These important soil groups will be discussed in the next chapter on page 114.

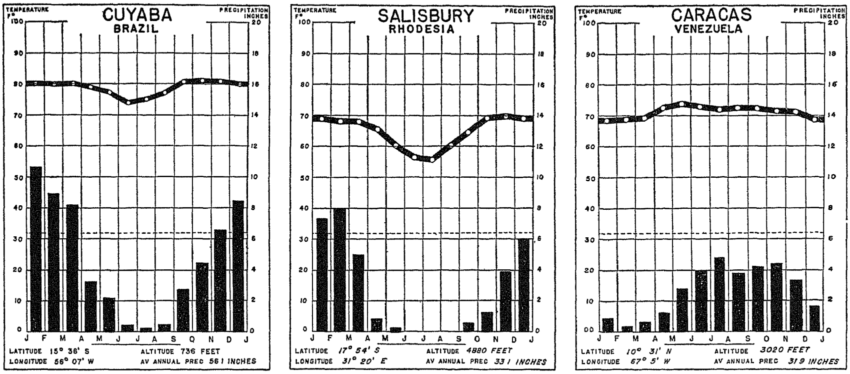


Figure 74. Three tropical-savanna stations selected to show the variety to be found within one climatic region. Account for the differences.

out the use of a plow because the grass must first be killed if cultivated plants are to survive. Primitive farmers, using only the hoe and digging stick, plant their gardens only in the forested parts of the savannas where the grass is not so well established.

Pastoral activities are widespread. In India and eastern Africa, large numbers of cattle have occupied the savannas for centuries. Throughout the Old World savannas the cattle are sacred and are bred irrespective of economic values. Their flesh is rarely eaten except in connection with religious ceremonials; their milk and hides remain the most important resource. The animals are so poor in quality that their output of milk and hides has an importance which is but a very small fraction of what one would expect from hundreds of millions of animals.

In the New World savannas, pastoral industries were introduced by the Spaniards. Today the savannas of Brazil, the Guianas, and Venezuela are occupied by herds of cattle tended by half-breeds. These animals are generally better than those of India and Africa, but they rarely offer serious competition to the cattle raisers of the temperate zone. Hides are the principal product entering the world market.

Agriculture is usually more advanced than in the rainforest. The land is easier to clear if plows are available, and the soil is more fertile. In the moister and more accessible coastal regions, this is a region of plantation and other types of agriculture which supply world markets. Rubber, cacao, oil palms, and certain spices cannot be raised because of the dry season, but the drier weather permits the addition of other crops, such as cotton, sisal, and peanuts. Rice is the basis of an advanced native agriculture in southeastern Asia. Mining is increasing in importance in the savannas as new railways open mineral deposits to world markets. Railways can be built more easily there than in the densely forested areas, and mineral deposits are more easily discovered where the soil is not concealed by a tangle of vegetation.

Highlands. Large areas within the tropical-savanna region have a climate which is cooler because of altitude (approximately 3° to 4° cooler for each 1000 feet of elevation). The largest of these areas are in south central Africa and southeastern Brazil, but many others can be identified on a physical map.

Where altitudes exceed 5000 feet, temperate vegetation and crops tend to replace those of the tropics; while at still higher altitudes, arctic flora are found. Tropical highlands, although limited in area, are of great importance, for the white man thrives there much better than in the tropical lowlands. The tropical highlands are, however, far from identical with the temperate regions, as can be seen by examining Fig. 74. Members of the white race often suffer from the very bright sunlight and the rarity of the atmosphere. Nervous diseases are common among Europeans who reside for a considerable period in such regions.

Most tropical highlands suffer from the cost of getting goods to world markets. For this reason, they rarely compete in the sale of temperate products, even

though these may be easily grown there. Coffee, tea, cotton, and minerals are the principal exports. Only coffee is common to almost all tropical highland regions.

QUESTIONS FOR DISCUSSION

1. Account for the regular distribution of climatic belts north and south of the equator in Africa and not in South America.
2. What occupations are likely to be permanently important in the tropical rainforest? in the tropical savannas? Why?
3. Is the exploitation of the tropics generally destructive exploitation? Explain.

The Low-Latitude Steppe

This climate (3A in Fig. 72), which is found in a large part of Africa, has, like the tropical savanna, a wet and a dry season but the dry season usually lasts more than half the year. The exact boundary between the steppe and the savanna is where the amount of evaporation equals the amount of rainfall. The steppe is therefore a region of moisture deficiency. The problem of drought is further aggravated by the extreme unreliability of the rainfall. Thus if man wishes to inhabit this region, he must conquer the problem of water supply by irrigation, by dry farming, or by nomadic hunting or herding.

The principal cause of this type of climate is the seasonal shifting of the wind belts. The trade winds blow over the region most of the year, and only during a few months do the doldrums or the monsoons bring convectional rains. These are summer rains except in a few small areas poleward from the low-latitude deserts where the rain comes in winter when the cyclonic storms within the prevailing westerlies move into the edge of the region.

The temperatures vary with the latitude. Usually there is a cool or only moderately warm winter season, a very hot dry season, and a hot summer season.

Flora and Fauna. Short grass occasionally interspersed with or replaced by drought-resistant shrubs and bushes is the characteristic vegetation. The fauna is similar to that of the tropical savanna but is sparser because of the lack of water and forage.

Soils. Only the alluvial soils along the streams are cultivated by means of irrigation. Little scientific work has been done on the soils of this region because they are, at present, of almost no economic value.

Topography. Streams are scarce and most of the major streams originate in moister neighboring regions. Temporary streams, formed after each convectional shower, have great erosive power and often cut deep canyons. Most of the time, however, the wind is the principal agent of erosion. Usually it blows away the lighter particles of soil and deposits them in sheltered hollows. The resulting features are often rounded except where resistant rocks rise sharply above the general level or where canyons have been cut below it.

Economic Development. Herding is the only common occupation except in scattered localities where mining, dry farming, or irrigation farming have been developed. Even the pastoral industries are risky, for grass and water are scarce during the dry season and during years of low rainfall.

Low-Latitude Desert

This type of climate (3B in Fig. 72) is the culmination of the decrease in rainfall from the equator poleward in the lower latitudes; it is practically rainless. Areas having this type of climate lie entirely within either the horse latitudes or the trade winds and, usually, in positions where the winds reach them only after blowing over land—as in the Sahara, Arabian, and Australian deserts—or after crossing high mountain barriers—as in the deserts on the west coasts of North America and South America and the Kalahari Desert in Africa.

In some cases, these desert areas are sandy, rocky, or salty wastes, but more often they are covered with a very sparse vegetation of grass, stunted shrubs, or cacti. So sparse is this vegetation that flocks must graze over tremendous areas to obtain enough herbage to keep alive. Surface streams, unless they originate outside the desert area, are absent and occasional wells and oases must be resorted to for a water supply. Rain is rare, but important. Usually it comes in short, heavy showers whose waters sink into the ground and nourish subterranean streams which supply the wells and form oases in depressions.

Desert temperatures vary greatly from day to night —especially away from the seacoast. Caravans often travel at night to avoid the heat and glare of the sunbaked soil and rocks. Desert clothing is usually heavy, loose-fitting, and made of wool. The typical Arab costume is ideal for desert climates, for it keeps out the heat of the day and the chill air at night. The many air spaces within the clothes serve as insulation, which is greatly needed where the midday temperatures far exceed blood heat and the midnight temperatures approach freezing at times.

Occupations. The world's largest desert area (extending from northwestern Africa to central Asia) is

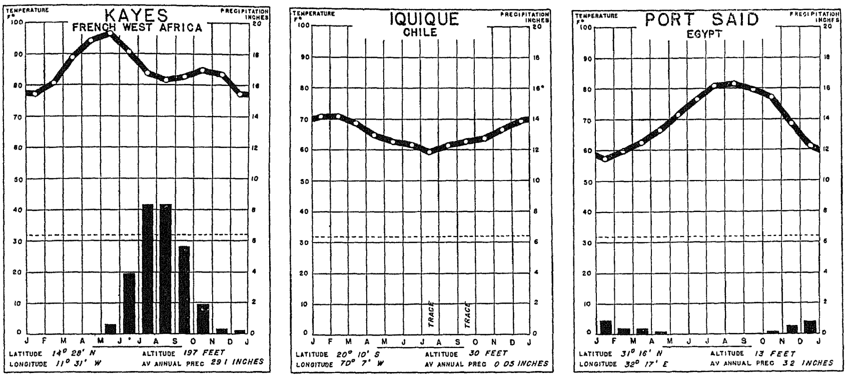


Figure 75 A low-latitude steppe station (Kayes) and two low-latitude desert stations. Locate Kayes and Iquique on Figures 37 and 38. Why the differences in temperatures between these two places?

inhabited by nomads who roam about seeking subsistence for themselves and their flocks. A rough life is theirs—they can carry but few goods on the backs of their camels and often must fight for wells, for pasture, and for food. In contrast, the oasis dwellers lead a peaceful life (except when hungry or greedy nomads raid the oasis) and have plenty of food and water. Many small oases are scattered throughout the desert and supply the nomads with dates, vegetables, grain, and water in exchange for meat, milk, and wool. More important to the world are the large oases of Egypt, Mesopotamia, and northwestern India, which are irrigated by rivers rising in distant mountains. Desert soils are often rich and productive when watered, and the floods caused by the seasonal rains are a blessing because of the mud and the water they add to the soil. Oases often support more than a thousand people to a square mile, and the larger oases are important producers of dates, cotton, and wheat.

Minerals. The evaporation of mineral-carrying waters often forms mineral deposits in desert regions. The nitrate supplies of Chile and the borax of southern California are two of the best-known deposits of this sort. Other minerals are easily found and mined in desert regions if food and water supplies can be obtained from adjacent areas.

QUESTIONS FOR DISCUSSION

1. In spite of their poor resources, the low-latitude deserts have played an important part in human history. Why?
2. Summarize the advantages and handicaps of each tropical climate.

The Mediterranean Climate

The Subtropical Climates. Subtropical climates differ from the tropical climates in having a winter season.[1] Though it is mild with only occasional frosts, the cold season is sufficient, nevertheless, to give relief from hot weather during a large part of each year and to stop the growth of many plants.

Subtropical climates may be divided into two regions the humid subtropical climate, which usually occurs on the east coasts of continents between latitudes 20° and 40°, and the Mediterranean[2] climate which usually occurs on the west coasts of continents between latitudes 30° and 45°. The outstanding difference between these two climates lies in the amount and distribution of the rainfall In the humid subtropical region, although there is a rainier period in the summer, the rainfall is usually adequate throughout the year. In contrast, the Mediterranean region receives so little rainfall that irrigation is commonly used and most of the rainfall occurs during the cooler half of the year [3]

The Mediterranean climate (5 in Fig. 72) takes its name from the area around the Mediterranean Sea. It is found in the transition zone between the dry

1 Parts of the low-latitude steppes and deserts have a short winter season which is, however, of little economic significance. If a more detailed classification were desired, these areas might be referred to as subtropical steppes and deserts.

2 Sometimes called the dry subtropical or dry-summer subtropical climate.

3 The Mediterranean climatic region and some adjacent steppes are the only important areas which receive almost all of their precipitation during the cooler half of the year.

belts of the trades and horse latitudes and the stormy prevailing westerly belt.

In many parts of this area the annual rainfall is less than twenty inches and it is hardly anywhere much over thirty inches. Throughout the summer months the area is under the control of the high-pressure calms of the horse latitudes. This gives bright, rainless weather In the winter, when the wind belts shift equatorward, there are occasional cyclonic disturbances which furnish most of the yearly rainfall. These are infrequent enough, however, so that even the winter has a large amount of sunshine.

Winter temperatures average 50°-55°, summer temperatures 70°-80°. The sensible temperatures are often more moderate than these averages indicate because of the low humidity. The fairly warm temperatures throughout the year are due in part to the latitude and in part to the coastal position. Interior parts of California—such as parts of the Great Valley, which is somewhat shut off from the marine controls by the Coastal Ranges—have somewhat greater extremes. Although frost may usually be expected on several days in a normal winter, really cold conditions are unknown.

Flora. Bushes, scrub forest, and bunch grass make up the characteristic Mediterranean vegetation. These drought-resistant plants were not usually of great value to man, and, in settled areas, have been almost totally displaced by crops and exotic grasses and trees. On hillsides and other rainier areas are found the open, evergreen, Mediterranean forests of oaks and conifers which have adapted themselves to the prevailing droughty conditions. The drier hillsides and some of those which have been cut over, are occupied by clumps of bushes interspersed with occasional stunted trees. Such vegetation is known as *chaparral* in California and as *maquis* in southern Europe. Mediterranean trees and bushes are characterized by drought-resistant features such as thick bark, small shiny leaves or needles, and extensive root systems.

The winter is the normal growing season. The vegetation is then a bright green, and flowers are common, especially toward the end of the season. During the summer drought most of the plants are a drab brown or yellow, relieved only by the dusty green of the rare trees and by the brighter green of the irrigated fields.

Soils. It is a happy coincidence that most of the Mediterranean areas consist of alluvium-filled valleys between ranges of hills and mountains. The prevailing soil in the lowlands is therefore a rich deep alluvium which has been little leached because of the moderate rainfall. On the hillsides, the soils are infertile and stony because the sparse plant cover does not protect them from erosion. In the long-settled lands around the Mediterranean Sea, such hillsides have been saved by a system of terraces (see Plate XX A), where the soil accumulates as it is washed downslope.

Topography. Mediterranean streams have many of the intermittent characteristics of tropical-savanna streams but their periods of flood come in the winter and spring instead of the summer. In the summer the smaller streams dry up; the rivers, however, still contain some water, partly because they rise in adjacent mountains and partly because they are fed by springs. This is of tremendous value to irrigation farmers.

Many of the streams change their gradient so much at the edge of the mountains that they cannot carry all their load. The surplus is deposited at the mouth of the canyon and forms a gently sloping cone of alluvial soil known as an *alluvial fan*. These fans are rich farming areas because they have both good soil and a potential source of irrigation water.

The soil does not freeze, consequently the runoff may erode the surface during the rainy winter. During and just after the dry season, when the plants lack most of their foliage, the rains from rare thunderstorms cause rapid erosion. In the summer, the wind adds to the destruction. Thus, throughout the year, the landforms mature rapidly.

Economic Development. Agriculture on the lowlands and terraced slopes, and grazing on the hillsides, are characteristic occupations. Everywhere this climate is associated with citrus fruits, olives, grapevines, grains (especially wheat and barley), sheep, and goats. Some of the irrigated areas raise crops such as rice, corn, and cotton, characteristic of the humid subtropical climate. Often there is a specialization in the growing of temperate and subtropical fruits and vegetables for distant markets, and, as a result, the grains which once provided the local breadstuffs have been displaced.

The Mediterranean climate is ideal for outdoor living the year around. At present increasing numbers of peoples are being attracted to the coastal districts of France, Italy, and California for health and recreation.

The Humid Subtropical Climate

This climate (6 in Fig. 72) is characteristic of east coasts of continents just outside the tropics. In the Northern Hemisphere, it is found in southeastern United States and southeastern China. In the South-

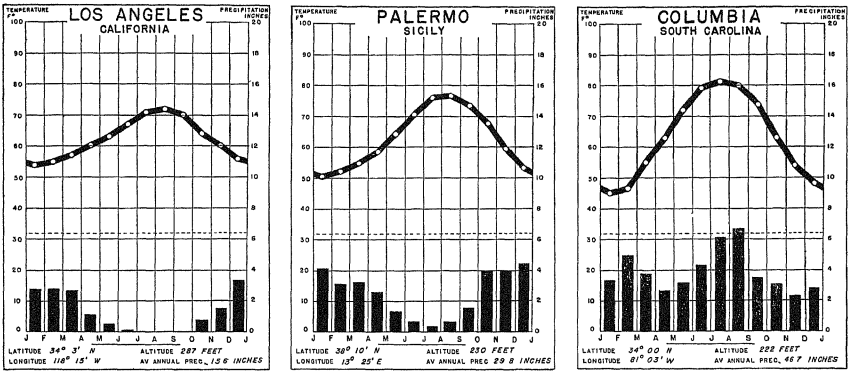


Figure 76. Three subtropical stations. What characteristics distinguish the humid-subtropical from the Mediterranean stations?

ern Hemisphere it appears in the region around the Rio de la Plata in South America, in southeastern Africa, and in southeastern Australia. In the last two instances it is confined by mountain ranges to a narrow zone along the coast.

The summers are hot and oppressively humid. Summer temperatures resemble those of the tropical rainforest but the average temperatures conceal the day to day changes in weather characteristic of this region but almost lacking in the tropical rainforest. The passage of cyclonic storms brings spells of hot, muggy weather, usually accompanied by thunderstorms, and followed by spells of warm, clear weather.

The winter temperatures average 45°-55°, but in the cooler half of this region cold waves cause killing frosts which occasionally do great damage by penetrating into the warmer half. The winter precipitation is cyclonic and almost never falls as snow. On the whole, the winters are mild, the growing season lasts over two hundred days, and, with care, some crops can be grown throughout the year in most of the region.

In southeastern China, the summer rains are associated with the monsoon which blows onto the Asiatic continent at that season. In winter the antimonsoon, blowing out from the Asiatic high-pressure area, gives relatively low temperatures to these subtropical latitudes.

In South America, most of the area having this climate is somewhat drier than the average for this type. It is similar to the western part of the American South (Texas and Oklahoma) but has less extreme temperatures because of its nearness to the ocean.

Flora. The common vegetation is a luxuriant forest which gives way to tall grasses on the drier westward margins of the region. The exact nature of this forest depends largely on soil conditions. For example, in southern United States, deciduous hardwoods of oak, chestnut, and tulip trees predominate on the clayey soils of the Piedmont; coniferous forests of loblolly, shortleaf, longleaf, and pitch pines predominate on the sandy coastal plains; and cypress and gums occupy the mucky soils of the fluvial swamps Many of these trees are found in cooler climates also, but then they take longer to mature because of the shorter growing season.

Soils. The soils of this region (commonly referred to as *red and yellow soils*) have many of the characteristics and disadvantages of the laterites of the tropical rainforest. This similarity reflects the high rainfall and temperatures found in both climatic regions. Also, as in the tropics, the fertile soils are usually those originating from alluvium, lava, or limestone, or are on gentle slopes. Elsewhere heavy applications of fertilizer must be used. The less humid parts of the region have by far the best soils—including chernozems, prairie soils, and chestnut soils. These subhumid soils are not extensively leached because of the moderate rainfall, and because of the protection afforded by a heavy grass cover.

Topography. As in the tropical rainforest, the stream network is well developed and the rivers are laden with mud. No snow or frost holds the soil in place in winter, hence cover crops are a necessity on cleared lands. Cultivated lands are rapidly eroded and if no precautions are taken, a hillside field may be destroyed by gullying in a few years. Rounded hills, broad flood plains, and deltas are common.

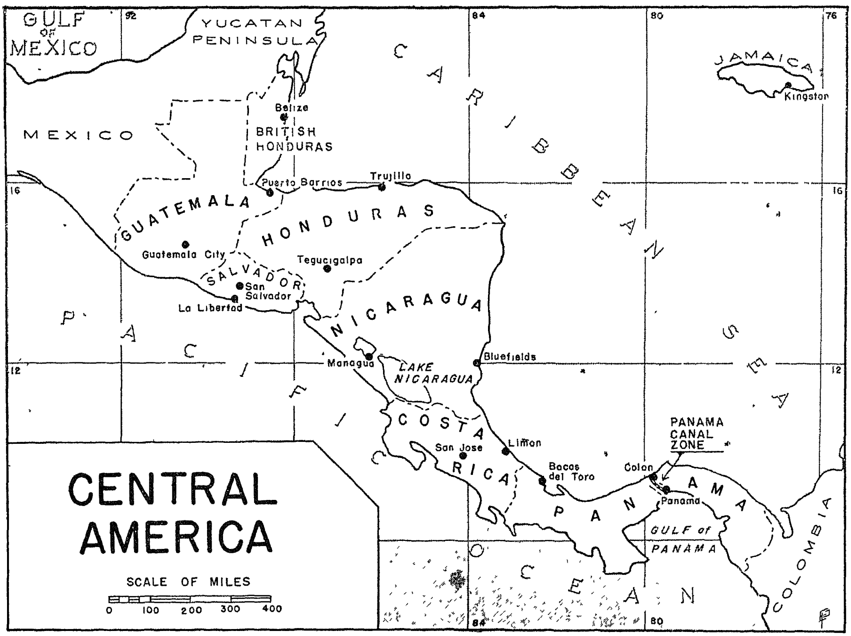
Economic Development. There is a tremendous variety of economic developments within this region, partly because it offers so many possibilities and partly because of historical differences. The longest-settled area, which includes most of the populous areas of China and Japan, had until recently a largely self-sufficient economy based on intensive rice cultivation. But during the past century this area has developed large exports of silk, tea, handicrafts, and textiles.

The American South was first known for its tobacco and naval stores, then as the world's supplier of cotton. Toward the end of the last century, such products as lumber, early vegetables, fruits, and manufactures were added to the staple products.

The Southern Hemisphere areas have, latitude for latitude, cooler summers, and are therefore not as well suited for raising cotton as the American South. On the plains of Argentina and Uruguay, grain-farming and stock-raising are major activities while, in the hilly lands of southern Brazil, lumbering, cattle-raising, and general farming predominate. The South African area raises a great variety of subtropical crops for consumption within the Union. The Australian area is a general farming region which supplies Sydney and Melbourne, the principal industrial and commercial centers of Australia.

QUESTIONS FOR DISCUSSION

1. Why is there no area with humid subtropical climate in Europe or northern Africa?
2. What facts given in the Bible prove that Palestine has a Mediterranean climate?
3. Why does the humid subtropical climate extend nearer the equator in Asia than in North America?



CHAPTER 14

CLIMATIC REGIONS OF THE WORLD: MIDDLE AND HIGH LATITUDES

In contrast to the tropical and subtropical regions, the following regions suffer from the problem of cold rather than the problem of excessive heat. Likewise they are characterized by greater seasonal changes in temperature than in rainfall. Frequent changes in weather are likewise characteristic.

The Middle-Latitude Climates. The name *temperate*—so often applied to middle-latitude climates—is a misnomer,[1] for the "temperate" climates contain great extremes in temperature, rainfall, and wind conditions. For the most part, they are within the prevailing westerlies, and the passage of cyclones and anticyclones within this wind belt is the principal cause of day to day change in weather. The great seasonal change, is, of course, due to the apparent northward and southward movements of the sun.

The middle-latitude regions are commonly considered ideal for the development of civilization. However, these regions have not been occupied by advanced civilizations for much more than a thousand years. Many climatically caused problems such as the heating of buildings, the storage of food for men and animals through the winter, the conquest of snow, and the adjustment to storms and other types of extreme weather, had to be solved before they could be exploited. The apparent ease with which these problems were met suggests that in the future perhaps equal progress may be made in the conquest of such environments as the tropical rainforest, the desert, and the subarctic and polar regions.

Marine West-Coast Climate

This climatic region (7 in Fig. 72) is found wherever the prevailing westerlies blow from the ocean over the land throughout the year The main control of this climate is the adjacent ocean which prevents temperatures from becoming extreme and keeps the humidity high (Fig. 77). Summers are cool and damp; the winters are mild and wet. Frosts at sea level occur only a few days of each year. Fogs and frequent cloudiness reduce the amount of the sunlight received and dull the common colors in the landscape. Rainy days are common, yet the total rainfall is not excessive (except where high mountains are near the coast) and the rain occurs in gentle drizzles rather than in thunderstorms. On the whole, this climatic region is the only part of the middle latitudes to which the term *temperate climate* may be appropriately applied.

Along the coasts, the maximum rainfall comes in the late fall and early winter when the winds from the relatively warm ocean blow over the land which has cooled to below ocean temperatures. Inland the rainfall is more evenly distributed throughout the year. The total rainfall likewise varies. Along the mountainous coasts of Washington State and Norway, 100 inches annually are common; on the lowlands the common precipitation is from 20 to 40 inches. But even where the total rainfall is small, drought is rare because the cool temperatures discourage rapid evaporation.

The North American Continent is unfortunate in that it has so little of this climate. The high ranges of the Cascades and Rockies prevent the marine influence from extending far inland. In Europe—where the mountains do not fringe the west coast, except in Scandinavia—this type of climate extends far into the continent and is dominant in the progressive countries of northwestern Europe. In extreme southern Chile, this climate is confined by the mountains to a narrow zone along the coast. New Zealand and a small portion of southern Australia and Tasmania also have this type of climate.

In Europe, the warm waters of the Gulf Stream Drift in the Atlantic help to carry this type of climate to very high latitudes on the west coast of the Scandinavian Peninsula. On the west coast of North America, a similar effect is produced by the warm waters of the Japanese Current.

[1] Nevertheless, this term is often used in this book for want of a more convenient one.

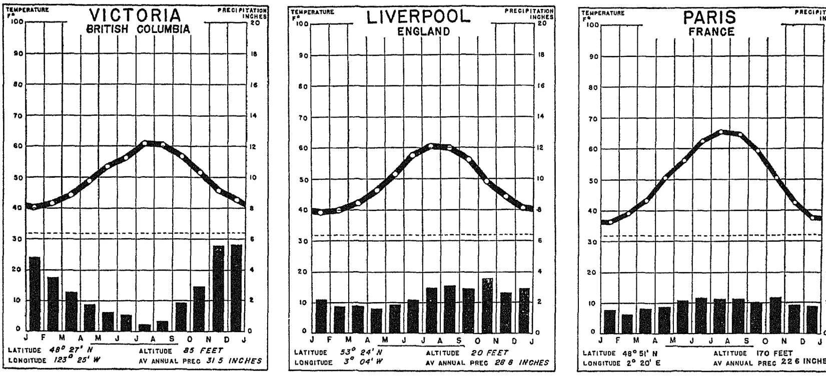


Figure 77. Three marine west-coast stations selected to show the variety within the region Compare Victoria with Palermo (Fig 76). Both have almost the same amount and distribution of rainfall—why then are they classified differently?

Flora. The cool, humid climate provides optimum growing conditions for those plants which do not require great warmth or much sunshine. Here the temperate forest attains its greatest growth, and grasses and bushes flourish on cleared lands or on soils too shallow for trees. Often the characteristic coniferous forest is so tall and luxuriant that it has been compared with the tropical rainforest by being called the temperate rainforest.

Soils. The soil is varied partly because the parent materials have been widely disturbed by glaciation. The predominant soils belong to an important group known as the *gray-brown podzolic*[1] *soils.* These are the best of the world's forest soils. Because of their moist environment, they are usually at least moderately leached. The decomposition of the forest leaves adds humus but also tends to make them acid. Often they are very fertile for some time after the forest has been cleared, but later they decline rapidly in fertility. However, they have an excellent physical structure and will readily absorb fertilizer. If carefully cultivated, they may be suited to almost any crop that the climate permits. It is this flexibility rather than any great fertility which makes them so valuable for diversified farming.

[1] Named from the process of *podzolization* which occurs in strongly acid soils An important part of this process is the solution and leaching of the iron and aluminum more rapidly than the silica from the A Horizon In laterites and related soils, the silica is removed more rapidly than the iron and aluminum Podzolic soils tend to be sandy in texture; lateritic soils tend to be clayey.

Topography. As in the humid subtropical regions, the stream pattern is well developed and the streams flow throughout the year. The landforms are rounded by erosion except where they have been partially rejuvenated by continental glaciation. The mountainous coasts have been glaciated and then submerged forming fiorded coasts such as those in Norway, Alaska, British Columbia, southern Chile and southern New Zealand. On the plains areas, as in northern Germany, the normal drainage has been upset by glacial deposits, and many lakes, ponds, and marshes have been formed.

Economic Development. This climate provides abundant moisture, a long growing season, and temperatures which are close to Huntington's optimum for human energy. Except for a few newly settled areas in the Southern Hemisphere, every part of this region is highly developed by progressive peoples. Lumbering, grazing, and fishing are the major industries in the more isolated or more recently settled areas; elsewhere except for a few rocky or swampy areas, the region is a beehive of industrial and commercial activity. The mediocre soils generally discourage farming except to supply near-by urban markets. Most of the region has summers too cool for corn and grapes and winters almost too damp for wheat. But for the growth of such fodder crops as potatoes, turnips, and grass, the cool, damp climate is admirable. Animal products, including butter, cheese, fish, and meats, are the only important foodstuffs ex-

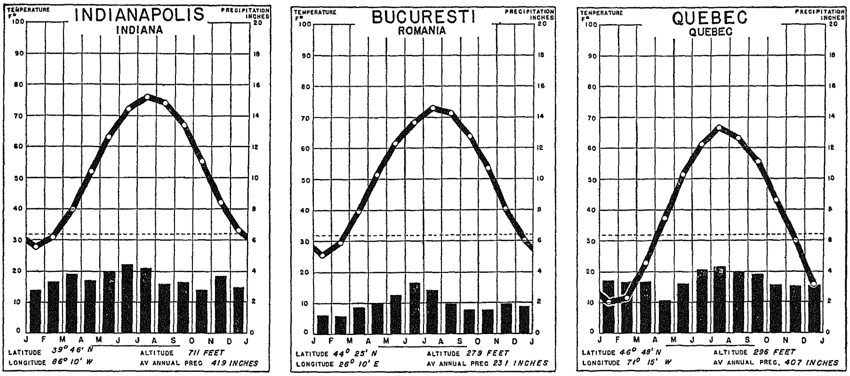


Figure 78 Three humid-continental stations Why is Quebec included in the short-summer phase of this climate?

ported; other foodstuffs are often imported into this region from areas with better soils.

QUESTIONS FOR DISCUSSION

1. Which of the characteristics of the marine west-coast climate are caused primarily by the prevailing westerlies? by the adjacent oceans? by the latitude?
2. What factors other than climate have contributed to the great economic development in the marine west-coast areas of northwestern Europe?
3. "The so-called temperate climates combine the winters of the subarctic with the summers of the tropics, only the spring and fall are truly temperate." Verify or disprove this statement by consulting the climate charts in Chapters 13 and 14.

The Humid Continental Climates

These climates (8A and 8B in Fig. 72) are characteristic of the moderately humid interiors and the east coasts of continents between approximately 40° N. and 55° N. Their continental location results in a considerable variation in temperature from summer to winter; their location within the prevailing westerlies subjects them to passing cyclones and anticyclones which cause great weather changes from day to day. In the winter, the cyclonic influence is especially strong and brings alternating periods of intense cold, snow (or possibly rain in the south), and mild weather. In the summer the weather ranges from warm to very hot with anticyclones occasionally bringing periods of cool weather. In the warmer and rainier half of the year, most of the rains are convectional and result from afternoon thundershowers rather than from cyclonic action.

A complication enters in the regions on the east coast of Asia having this climate. The summer rains are largely due to the monsoon and the winter is colder and drier than average due to the antimonsoon. On the west coast of the Japanese islands, there is a winter maximum of rainfall due to the antimonsoon blowing off the Japanese Sea onto the mountains.

The humid continental climate has been subdivided, but the difference between the long-summer and short-summer phases is primarily one of temperature. The consequences of this difference will appear under many of the topics below.

Flora. Deciduous forest is the characteristic natural vegetation but it is replaced by mixed and coniferous forests in the northern half and by tall-grass prairies in the drier interior areas The indigenous deciduous forests with their fine birches, beeches, oaks, and hickories were once of high quality, but the axe of the farmer and lumberman soon cleared the best of them. The soil was thus exposed to leaching and erosion, and the second growth forest was adjusted to poorer soil conditions and included many conifers. Today only the lands not suited to farming have been allowed to remain in forest.

Soils. The gray-brown podzolic soils predominate, but important areas of other soil groups are found on the borders of the region. The variety of soils was increased by continental glaciation which affected most of the region.

In the moister part of the short-summer phase (for example, eastern Canada), *podzols* predominate. These are infertile soils partly because the rock particles

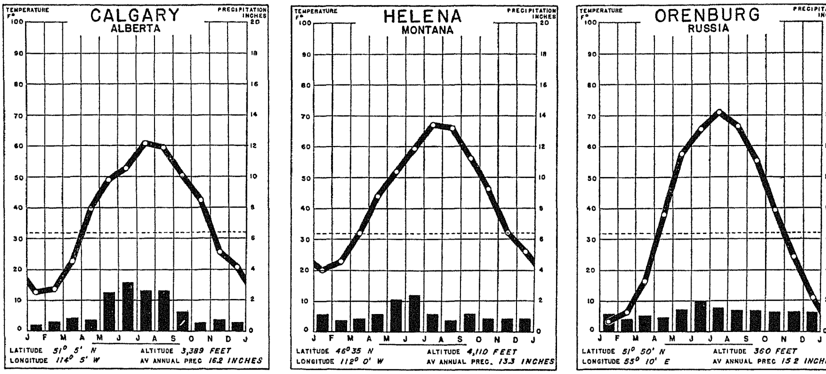


Figure 79 Rarely is there a sharp change at climatic boundaries. Thus Calgary, on the drier boundary of the humid-continental, short-summer phase, region is only slightly different from Helena which is included in the middle-latitude steppe region. Orenburg illustrates the extreme temperatures experienced toward the center of the world's largest continent (Eurasia).

decompose so slowly in the cool climate and partly because they are acid and leached. Often they are stony because of glaciation. Since they can only be used for a few crops such as hay, rye, barley, and potatoes, they are generally left in coniferous forest.

Toward the drier interior of the continents, the *chernozems* and the *prairie soils,* a group of soils transitional between the gray-brown podzolic soils and the chernozems, are important. The chernozems received their name from a Russian word meaning *black earth* which was first applied to a large area of these soils in the Russian wheatlands. The dark color of these soils is due to the large amount of humus derived from the decomposing grass roots found in prairie areas. The chernozems are the world's *de luxe* soils and have so many good qualities that highly cultivated and fertilized soils often take on the characteristics of a chernozem. They require little, if any, fertilization and, furthermore, they do not tend to become leached or acid, since the rainfall in these regions is only sufficient to carry dissolved material as far as the B horizon where it can be obtained by deep-rooted plants. Unfortunately, these soils are only suitable for wheat, rye, barley, and other grassland crops because of the low rainfall. The *prairie soils* just east of the black soils in the United States possess most of the good qualities of chernozems and, although poorer, are more varied as to amount and kinds of crops produced because of the greater rainfall.

Topography. The effects of climate on landforms are very similar to those in the marine west-coast region. Rounded topography, partly rejuvenated by glaciation, is characteristic. Unlike the marine west-coast areas, much of this region is snow-covered throughout the winter and its streams and lakes are frozen over. Erosion is thus retarded during the cold season.

Economic Development. So highly diversified is the development of these regions that a complete account would be almost a catalogue of temperate-zone occupations. The short-summer phase of this region includes the hunters and lumbermen of Siberia, the peasants and industrial workers of central Russia and Poland, the dairy farmers of southern Canada and northeastern United States, and the spring wheat farmers of the Dakotas and the Prairie Provinces of Canada. The long-summer phase includes the peasants and industrial workers of east central Europe, the densely populated farming areas of northern China, Manchukuo, and Chosen, the industrial workers of central and northeastern United States, and the corn and winter-wheat farmers of central United States. This large climatic region is probably the most productive of all the world's climatic regions. Not only does this region possess the climatic requirements for the growth of many valuable native plants and cultivated crops, but its temperatures, humidity, and changeability make it a close rival of the Marine West Coast areas in climatic stimulation.

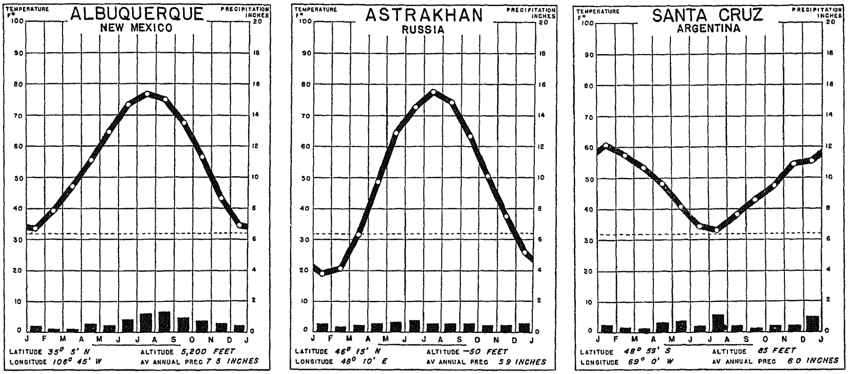


Figure 80 Three stations selected to show the variety within the middle-latitude deserts Middle-latitude deserts are rarely as arid or as barren as low-latitude deserts.

Middle-Latitude Steppe and Desert

These regions (4A and 4B in Fig. 72) are the temperate-zone equivalents of the low-latitude steppe and desert. They are located within the prevailing westerlies either in the interiors of continents or in the rain shadows of mountains They are arid because the winds reaching these regions have dropped most of their moisture nearer the sea or on the other side of the mountains. There is a considerable variation in rainfall from place to place and from year to year. The average annual precipitation is everywhere less than twenty inches in the steppes and less than ten inches in the desert.

Most of the rainfall comes in short, convectional showers in the summer, although there may be a small amount of winter rain of cyclonic origin.

The temperature range between seasons is often extreme because of the continental position of these regions. Likwise the diurnal range in temperature is very great.

Flora. The vegetation of the middle-latitude steppe usually consists of short, shallow-rooted grasses. As the drier areas are approached, the continuous grass cover is replaced first by bunch grass and then by drought-resistant shrubs such as sage-brush. Mountainous areas or areas near streams may have a cover of either chaparral or open coniferous forest.

Soils. Three major soil groups occupy these regions: the *brown soils,* the *sierozems* (Russian: gray earth), and the *desert soils.* The desert soils are sandy or gravelly because the finer particles have been blown away by the wind. The steppe soils (brown soils and sierozems) are sometimes fine because the dust from the adjacent deserts have been deposited there and held in place by the grass.

Since there is little rain to wash away the plant nutrients, these soils are often very productive when properly irrigated. The rapid evaporation of irrigation water tends, however, to leave a residue of mineral salts (*alkali*) which may, in time, hamper plant growth. Although methods are known by which this may be prevented, many irrigated regions have been permanently ruined by careless or ignorant soil management.

Economic Development. In all parts of the earth, these regions belong to the pastoral nomads. Wheat farmers have penetrated into the less arid parts of the steppes in southern Russia and in the Great Plains of the United States but their crop yields have been low and uncertain. Only where streams from the mountains form oases or where valuable mineral resources are present, are there any large settlements.

QUESTIONS FOR DISCUSSION

1. If the Rocky, Cascade, and Sierra Nevada mountains were moved eastward one thousand miles, how would the climate of the United States be altered? Would such a move be beneficial? If the Appalachians were moved westward one thousand miles, what climatic changes would result? Would this move be beneficial?
2. Which is most productive: an oases in the middle-latitude desert or in the low-latitude desert? Why?
3. Compare the world maps on pages 97, 100 and 120.

The Subarctic Climate

Poleward from the short-summer phase of the humid continental climate lies the world's most continental climate (9 in Fig. 72). It lies largely in the interior of the northern continents, at very high latitudes in their western portions, extending to surprisingly low latitudes on their eastern coasts. The southward broadening of this belt toward the east is due to the increasing distance from the modifying influence of the sea in a region of prevailing westerly winds.

The rainfall of this type (Fig. 81) is low, being usually in the vicinity of fifteen inches a year. From a crop-growing standpoint this is not so significant as it may seem. Most of it falls in summer and the rate of evaporation is so low that the effectiveness of this rainfall is very great.

Temperatures are subject to the greatest yearly extremes in the world. Verkhoyansk (eastern Siberia), which represents extreme conditions, is almost as isolated as possible from oceanic influences. Here the July average reaches 66° (about that for Montreal for the same month), while the January average drops to 58° below zero. The growing season is very short in number of days (often as short as sixty days), but somewhat longer in hours of sunlight because, for some months in summer, the sun does not set in the northern parts of the regions affected.

Flora. The native vegetation is coniferous forest; spruce, fir, larch, and pine are the most characteristic trees. Such hardy deciduous trees as birch, willow, and poplar may make up as much as one-quarter of the forest. The trees are tall and close together in the southern part of the region, but the forest becomes open and stunted towards the north. Large areas of lake, swamp, bare rock, and moorlands further reduce the amount of lumber available.

Fauna. Wild animals have not been mentioned in the discussion of the subtropical and middle-latitude climates because in those regions domesticated animals have largely replaced the indigenous fauna. In the subarctic climate, fur-bearing animals are among the leading resources. Less desirable are the myriads of insects which make life almost unbearable during the summer.

Soils. Infertile ash-colored podzols prevail. The soils are usually frozen to a considerable depth and do not easily thaw out in summer. Along a few rivers and lakes, richer alluvial soils are found, while many areas have had their soils scoured away by the continental glaciers.

Topography. Ice and snow are the principal causes of the characteristic erosional features. The continental glacier was responsible for the bare rocks, the morainal ridges, the extensive swamps, and the innumerable lakes and ponds. Ice today is an important agent in breaking up the surface rocks. Finally the melting snows in the spring flood the rivers and so expand the already extensive swamps.

Economic Development. The population is sparse. Agriculture is limited to the more favored sites and is devoted largely to potatoes, oats, hay, and other crops adapted to the sour soils and short growing season. Hunting and fishing supplement the meager agriculture, and reindeer herding is common in the Old World and has been recently introduced into Alaska and northern Canada. The long, bitterly cold, dark winter not only makes living precarious from a physical standpoint, but apparently also has depressing psychological effects on many of the inhabitants.

The Tundra Climate

This climate (10 in Fig. 72) is characteristic of the northern shores of the continents in the Northern Hemisphere. The precipitation is very low. Temperatures are not so extreme as in the subarctic type, but are more consistently low. There is a short season of continuous sunlight and moderate warmth when the light snow cover disappears and the top few feet of the soil thaw out. Flowers and grasses flourish during this season. The winter is long, cold, and dark with relatively little snow. The population consists of a few Eskimos and similar peoples living close to the sea, getting their sustenance largely from hunting, fishing, and in some areas from reindeer herding.

The Polar Ice Caps

A limited area (11 in Fig. 72) of the polar regions has the perpetual ice and snow which are often falsely assumed to exist everywhere beyond the Arctic and Antarctic circles. Such a condition can exist only on very high land or on land distant from the sea in extremely high latitudes. These qualifications are met in large areas only on the Plateau of Greenland and in the high interior of the Antarctic Continent. In such regions, no month has an average temperature above 32° F. For this reason, the scant snow of each year has accumulated throughout the centuries to make the great snow caps and ice caps which exist there. These ice caps with their low temperatures and high pressures probably have a decided influence on middle-latitude weather.

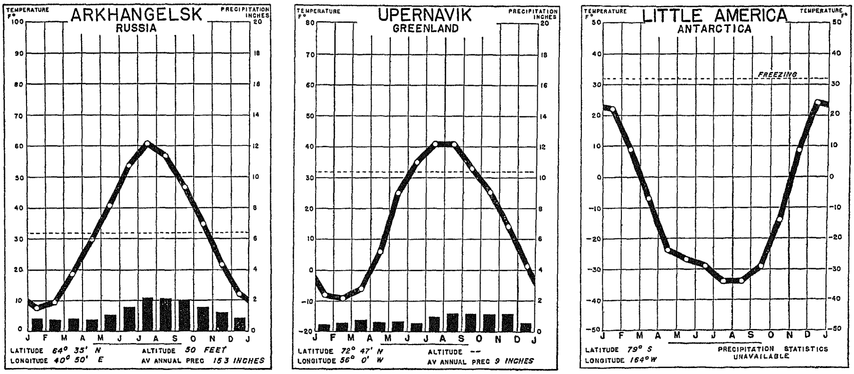


Figure 81. Three stations selected to represent the climatic types of the subpolar and polar regions. Note that the temperature scales start from different bases on each chart

Mountain Climates

Very little can be said about the climates of mountain regions which will be true over any wide area except that they are cooler and more humid than adjacent lowlands. Both temperature and precipitation vary markedly over short distances because of differences in altitude, slope, and exposure to the wind and sun. There is usually a considerable range of temperature between day and night because of the "thinness" of the air. In the western part of the United States, the interior mountain areas usually have more precipitation than the lowlands because they wring some moisture even from the predominantly dry winds. The mountains facing the Pacific cause a very heavy precipitation from the moist winds off the ocean, and the Sierras and the Cascades have heavy rain in summer and very heavy snowfall in winter. This is of special significance because streams feeding on the precipitation of these mountains furnish the irrigation water for the parched lowlands at their feet. No type station will be given for this class because none would be typical. Almost every mountain valley has a climate of its own.

Certain climatic characteristics of mountains influence strongly their habitability. For example, the sun's rays are strong there and outdoor sensible temperatures in the sun are often high even when the shade temperatures are low. The sunset is accompanied by a sharp drop in temperature The sunny slopes may have subtropical while the shady slopes in the same valley may have almost subarctic conditions.

The lower atmospheric pressures in mountainous regions restrict human activity. The pressure at 11,000 feet is only about two-thirds that of sea-level. The rarity of the air makes it difficult for the body to take in sufficient oxygen for great activity. Mountain sickness with its symptoms of headaches, faintness, and nausea is common among new arrivals at high altitudes.

In arid and semiarid regions, mountains produce islands of moisture. The heavier precipitation they induce feeds streams for irrigation, clothes their slopes with forests, and, in high mountains, produces snow caps which keep the streams running through long dry seasons

The above generalizations supplement those presented in Chapter 6 and on pages 82-83. All these statements are subject to considerable modification in particular cases because unusual configurations in the topography or unusual surroundings cause striking variations in mountains.

QUESTIONS FOR DISCUSSION

1. How extensive are the Southern Hemisphere areas with each of the types of climate discussed in this chapter? Explain fully.
2. Why are temperatures more extreme in the subarctic than in the tundra type? Why is there so little precipitation in the subarctic and tundra climates?
3. A mountain 20,000 feet high is located between an area of tropical-steppe climate and an area of low-latitude desert What climatic conditions would you find at various altitudes on each side of the mountain? Describe climatic conditions on and about the mountain if its location were in the prevailing westerlies.

REVIEW QUESTIONS ON PART TWO

1. Check list of new terms. Can you illustrate each with an economically significant example?
   - continental shelf, submerged coast, emerged coast
   - topography, relief, physiography
   - topographic youth, maturity, old age
   - age cycle in streams, rejuvenation
   - diastrophism, seismology
   - faulting, fault line, block mountains, folded mountains
   - weathering, erosion, corrasion
   - terminal moraine, U-shaped valley
   - base level, peneplain
   - stratification, metamorphism
   - plateau, mesa, dissected plateau
   - flood plain, coastal plain, natural levee
   - limits, optimum
   - soil, loam, humus, horizon (A, B, C)
   - residual and transported soils
   - leaching, irrigation, dry farming, mulching
   - soil acidity, legume, fallow
   - chernozem, podzol, gray-brown podzolic soil, prairie soil, loess, laterite
   - weather, climate, sensible temperature
   - relative and absolute humidity, dew point
   - conduction, radiation, convection, insolation, circle of illumination, equinox, solstice
   - precipitation, evaporation, runoff, ground water, water table
   - artesian well, interior drainage
   - doldrums, horse latitudes, trade winds, prevailing westerlies
   - monsoon effect, land and sea breeze
   - Gulf Stream, Japanese Current, Humboldt Current
   - polar front, cyclone, anticyclone, tornado, thunderstorm, hurricane
2. Is this statement true? "Similar climatic and soil conditions are found in all lands having the same latitude." Explain.

Part Three: FOODS, RAW MATERIALS, AND FUELS

CHAPTER 15

FORESTS AND FOREST INDUSTRIES

MUCH of man's economic history has been concerned with his adjustment to the forest. It was probably his first home and furnished him his first shelter and food. When he attempted agriculture, the forest was at first a handicap, but as improvement in his tools gave mastery over it, forest products became important resources. Each new use of wood—from the discovery of fire to yesterday's announcement of a new wood distillate—marks a milestone in economic history.

Forest lands contain favorable conditions for many occupations. Because most of these occupations are more intensive and profitable than forestry, a large part of the world's forests has been cut down to make room for other land uses. Except in those protected by law, the residual forest lands usually have some handicap of soil, relief, climate, or position which prevents the more intensive use of the land.

Stages of Forest Utilization

Most forests tend to go through several stages of utilization. Usually the examples of the early stages are found in isolated areas or in lands useless for other purposes; while the later stages of development are most common in those regions which have long been settled by peoples with a complex economy. The following discussion will arrange forest areas according to their present manner of utilization rather than by geographical position.

The Hunting and Collecting Stage. Man in this stage utilizes only a very small part of the forest environment. Nuts, seeds, fruits, roots, and the meat of wild animals provide his food; skins, furs, and materials made from bark and leaves are used for making clothing and building shelters; stones and limbs broken from trees supply the raw materials for tools and weapons. Such direct adjustments to the forest environment are found in many climates. The Ostyaks of Siberia, the Indians of northern Canada, the Pygmies of central Africa, and some of the Indian tribes of the Amazon Valley are all illustrations of this stage. Varied as these peoples are in details of clothing and food, they are similar in the simplicity of their economy, their self-sufficiency, their small numbers, and in their dependence on the more obvious resources of the environment. These peoples enter into the world economy only when some product they are accustomed to using is demanded by the outside world. Trapping for furs and rubber gathering are outstanding examples of this. When such a development takes place, the trading post becomes a middleman which connects these peoples with the rest of the world.

The only large areas outside of the tropics remaining in this stage are the northern coniferous (cone-bearing) forests of Canada and Eurasia. Compared with other forests, this type is relatively uniform in composition and consists of pine, spruce, fir, and larch (softwoods), and birch and aspen (hardwoods).[1] This vast forest extends from roughly latitude 45° to the Arctic Circle. The extent of this area is tremendous, but in the past its value has been greatly exaggerated. This was due in part to the common use of the Mercator's projection—with its exaggeration of areas in the upper latitudes—and in part to the inaccurate reports of early explorers who judged the country by the forests they found along the streams. Further

[1] Softwoods are usually the woods of coniferous (cone-bearing) trees. Hardwoods are usually the woods from deciduous trees. Some "softwoods" are harder than woods known as "hardwoods." Many of the trees in the tropics, although classified as hardwoods, closely resemble the softwoods in their properties. The common woods are divided as follows (United States Forest Service).

Softwoods	*Hardwoods*
Pines, firs, hemlock, spruce, cypress, larch, cedar, redwood	Oak, maple, poplar, gum, chestnut, beech, birch, basswood, elm, cottonwood, ash, hickory, walnut, cherry, sycamore

Softwoods generally grow in poorer soil and under more severe climatic conditions than hardwoods.

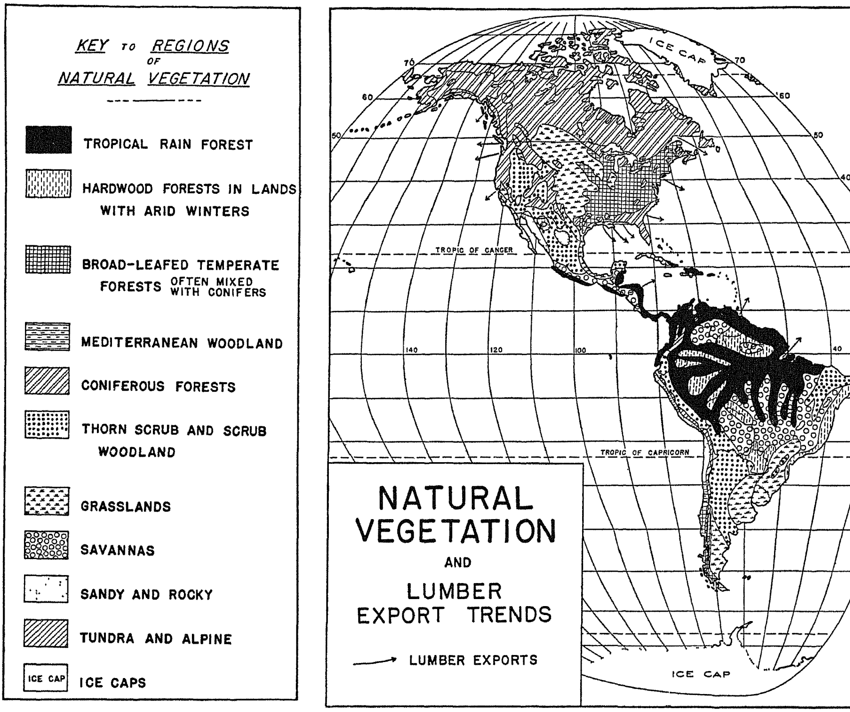


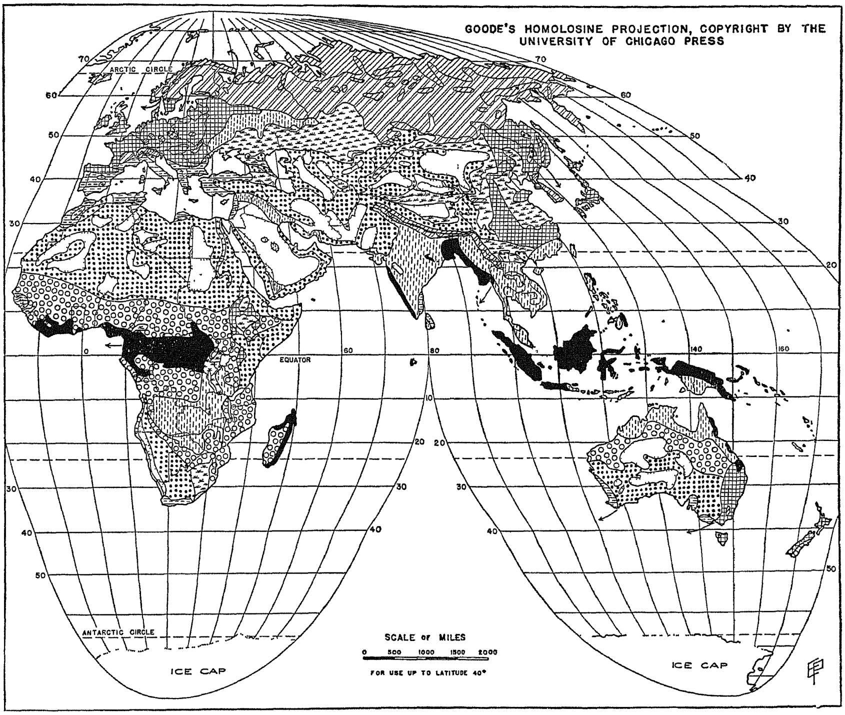
Figure 82. Compare this map with Figure 72.

exploration, especially by air, has shown that many of the areas between the streams are almost treeless because of aridity, exposure to cold winds, or poor soil conditions. The value of the trees in the northern part is lessened because they are much smaller and more widely scattered than near the moister and warmer southern margin.

Where river or rail transportation is available, the northern forest is easily exploited, since all of its trees are useful either as lumber or for wood pulp. But much of the area is still untapped by railways, and the rivers in northern Canada and Siberia generally flow northward (*i.e.*, away from the market) and are frozen much of the year. Hence these areas remain largely in the hands of primitive hunters, and furs are the main export.

The Forest-clearing Stage. In the tropics, most hunting and fishing peoples have added a primitive form of agriculture to their forest economy. They cut down a small portion of the forest, burn much of the lumber (partly to get rid of it and partly to use the ashes as fertilizer), and then plant their crops among the stumps. The intensive utilization of this limited area and the thorough leaching by the heavy tropical rains cause rapid exhaustion of the soil. The primitive farmer then moves on and makes a new clearing, while the deserted field grows up into a tangled jungle of trees and vines.

A similar use of the forest is found in more advanced economies in association with one-crop agriculture. In the Cotton Belt of the United States it was once common to abandon fields when the soil was



exhausted and clear new fields This method is still used to some extent in the Cuban sugar industry.

The forest-clearing stage is common in the tropical rainforests of Africa, South America, and the East Indies. The total area cleared for nomadic agriculture is but a small part of the whole forest. Only where the forest thins out, due to the approach toward the savanna climate, does farming become predominant.

When men clear a forest and then desert it, the new trees which come to occupy the land are not the same as those cleared from it Nature cannot replace the original natural vegetation within a short space of time. The virgin forest was often the *climax* (or final stage) of thousands of years of plant occupancy, and another long period is necessary before a similar *climax vegetation* may be attained. Consider the result of cutting off a virgin forest of tall pines! The site is denuded of vegetation, and the rain washes away much of the surface soil. After a few years the land will be occupied by thickets—perhaps blackberry bushes and similar vegetation. Gradually, small trees grow up among the bushes and finally, after many years, succeed in replacing them. The roots hold the soil in place and prevent erosion, while the falling needles add humus to the soil. The trees grow slowly in the recuperating soil until they crowd each other, and the weaker trees die because of the too strenuous competition. Finally, after a century or more of tree occupancy and soil recovery, the forest, if it has been untouched by man, recovers many of its original characteristics. When this climax is reached, it will probably retain this form until man or environmental changes interfere again.

The Permanent Clearing Stage. When the United States was settled, a major problem was to get rid of the forest and make room for farmlands. Often the best stands of trees were cut first because the pioneers had learned that the kind and quality of trees were dependable indicators of the potential agricultural value of the land. Trees such as oaks and hickories indicated a more fertile soil than pines. Lands occupied by beeches and sugar maples were judged better than those occupied by an oak-pine forest.

Within the settled regions, most of the land was cut over once by the lumbermen, but those areas not suited to farming were abandoned to the forest. Thus the rugged lands even in regions of high development, regained their forests, which remained as a source of firewood and timber and as regulators of erosion and drainage. In Germany and some other countries, certain forests are known as *protection forests* because of their part in flood prevention. Any cutting of trees in such forests is strictly regulated

Regions of poor soil also tend to remain in forest, even when they have excellent positions. Illustrative of this are the thousands of square miles of forests which occupy the infertile sandy soil within one hundred miles of New York and Philadelphia. Elsewhere, fields which have been abandoned because of soil exhaustion have been reclaimed by the forest. Sometimes this is done by governmental reforestation of lands confiscated for nonpayment of taxes. Nature may replace the forests, but such a second-growth forest, in its earlier stages, usually contains many quick-growing and relatively valueless trees.

QUESTIONS FOR DISCUSSION

1. What do each of the following plant indicators tell about the environment tall-grass, short-grass, cactus, scrub oak, cranberry, date palms, olive trees, coconut palms?
2. Why is the second-growth forest less valuable than the virgin forest which occupied the same area? How can the second-growth forest be improved?
3. Why have the inhabitants of the northern coniferous (subarctic) forests seldom advanced beyond the hunting and collecting stage?

The Forest—"Mine" or "Crop"?

Human adjustments to the forest, as a source of fuel and of raw material for the woodworking and paper industries, are by no means uniform. These adjustments vary, not only in accordance with differences in extent, nature, and position of the forest, but also with differences in the density of the population and in the nature of the controlling social, political, and economic systems. There are many possible classifications of these adjustments, but for the purpose of distinguishing between the two dominant types present in the world today it will be sufficient to divide them into (1) those in which lumbering is carried on as though it were a mining operation—removing the forest and abandoning the region, and (2) those in which the forest is regarded as a crop which is prudently tended to yield a continued harvest. Very few areas belong entirely within one of these classes, and there are "shadow zones" between them. In addition, there tends to be a historical development from the first type of exploitation, when a region is "new" and the forest is, apparently, inexhaustible, into the second type when the pinch of exhaustion begins to be felt and conservation becomes a necessity.

The Migratory Lumber Industry of the United States. The history of forest utilization in the United States is a classic instance of the "mining" of trees. In colonial times, the most habitable portions of the North American Continent were covered with the largest forest of commercially valuable timber within recorded history. Trees were not only so plentiful that there could be no thought of a possible shortage, they even occupied the best land that the settlers needed for the growing of food. As a result, excellent timber was cut off and burned off to make way for agriculture. There was thus a tremendous *loss* of forest resources, but it is not at all certain that this *loss* could be termed *waste*. *Waste* involves *avoidable loss,* and there was no market for any appreciable quantity of this timber; and, even if there had been, no adequate means of transport existed except along the seaboard and the rivers. The scarce element was agricultural land, not timber.

But as soon as any considerable area had been cleared, the situation began to reverse itself. The increasing agricultural, industrial, and commercial population meant increasing demand for wood. This caused the removal of the timber from even the poor soils and rugged lands near the market and the utilization of more distant supplies. The poor lands near the market were cleared of every bit of timber that could be marketed and were then abandoned—for was there not an unbroken forest extending for unlimited distances into the interior, and were not new methods of transport making this forest more accessible? The attitude of a vigorous people confronted with apparently limitless resources could not well have been different. In addition, transport was becoming cheaper, labor to tend regulated forests was expensive, interest

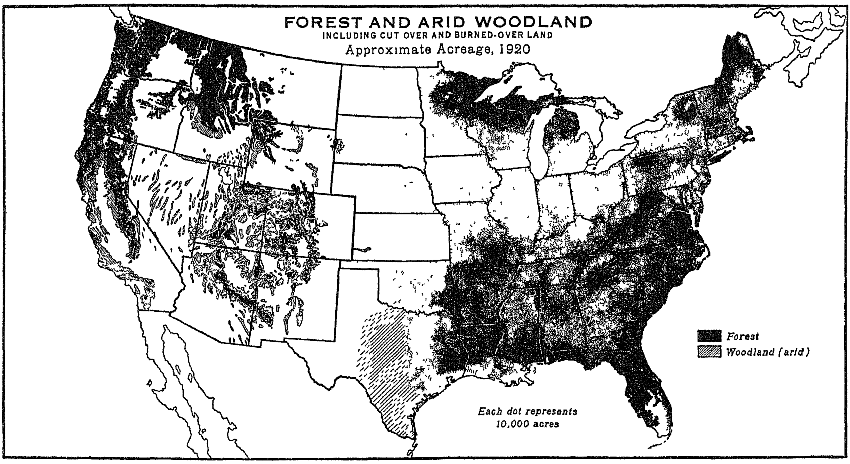


Figure 83 This and numerous other maps of the United States in this text are taken from the valuable *Graphic Summary of American Agriculture* (U S. D A, new editions after each census).

rates were high, and no one could afford to engage in such a low-income activity when labor and capital could be so much more profitably invested in the destruction of new forests or put into other forms of resource exploitation nearer home.

As a result of this situation, the center of commercial lumber industry in the United States moved progressively westward and southward, away from the markets in the densely populated areas. Up until 1850, New England—with its unsurpassed white pine—retained the lead in lumber production. From 1850 to 1870, the center of the industry was in New York and western Pennsylvania Then it moved westward to the mixed hardwood and softwood forests about the Great Lakes The softwoods were removed first, but the hardwoods in this region still yield a considerable harvest. By 1900, the center of the industry had shifted to the South, where there were great stands of yellow pine in the lowlands and mixed pines and hardwoods in the uplands. By 1915, the center of production had shifted to the pine, fir, and spruce forests of Washington and Oregon, although the South is still a very important lumbering region and promises to continue so.

It was to be expected that the sawmilling industry would migrate with the shift in the supplies of raw materials, but, in addition, numerous other industries using wood have been forced to migrate or to use increasingly more expensive raw materials from distant sources. These include the furniture industry, the veneer industry, the sash and door industry, and those industries manufacturing buckets, handles, toys, baskets, boxes, and barrels. The passing of local raw materials involved tremendous loss, not only to the manufacturer who was forced to abandon expensive plant and equipment, or to sell at a loss, but also to the inhabitants of many towns and cities built around wood utilization, who were deprived of their principal source of livelihood and the principal support, through taxes, of their community services.

The Permanent Forestry Industry of Sweden. The developments which have taken place in Sweden since 1900 serve as an excellent example of the opposite pole of man's adjustment to forest resources, that is, the production of timber as a "crop." In that country, however, physical and cultural conditions are markedly different from those in the United States Most parts of Sweden have a climate too cold and a soil too sour to offer their inhabitants much inducement to clear land for agriculture. More than half of Sweden is suited to forest growth and little else. The Swedes are an "old" and conservative people, growing in numbers but slowly. The country also

has few other resources to attract labor and capital, and the forests are its greatest resource.

By 1900, Swedish leaders had realized that the time was ripe for the introduction of a system of rational management of this resource if growing consumption and decreasing supplies were not, ultimately, to destroy the nation's most important asset. Although regulation of public forest lands had existed for some years, it was not until 1905 that public regulation of forestry on private lands went into effect. The control is largely exercised through local conservation boards whose functions are to enforce conservative methods of cutting, to leave seed trees or to provide for replanting, to protect the forest against fire and pest, to disseminate seed and plants, and to carry on a wide range of educational work. There are also a number of forestry schools and colleges which teach forest management and inculcate the principles of conservation. The result has been that, in spite of a tremendous increase in domestic consumption and export, the supply of timber available for cutting is greater today than it was in 1905. This has come about because the Swedish public has been convinced that rational forestry pays.

The Farm Wood Lot and Other Small Managed Forests. In many parts of the world where farms represent only the best land cleared from the original forest, a combination of farming with the management of the remaining forest has been successfully developed. The winter season, when there is little other demand for the labor of man and farm animals, and when snow often facilitates hauling, is devoted to getting out firewood, fence posts, and lumber for farm use and for sale. This furnishes an income from poor land which, if properly managed, is continuous and, up to the point of maximum efficiency of the forest, increasing.

In many countries in northwestern Europe—notably in Germany, Austria, Poland, and France—there are municipal and private forests which are carefully managed and prove an excellent investment. They support local woodworking industries, and they make firewood and lumber available to local communities. In addition, they serve as cover for wild life, as windbreaks, and as "protection forests" to prevent erosion and protect water supply.

These regulated European forests differ from the typical American forest in appearance as well as in use. The trees are planted at regular intervals so that they do not crowd one another. Frequent roads intersect the forest, often forming a regular checkerboard. These serve as firebreaks and also provide an easy way of removing logs from the forest. The forests are kept clear of underbrush, both to lessen fire risk and to prevent undue drain on the soil. Every few years, the forests are thinned out to prevent crowding of the remaining trees. These thinnings provide fence posts and firewood, while saw timbers are obtained when full-grown trees are cut. The land they occupy is immediately replanted. The amount of wood removed each year is limited to the additional number of board feet added by the natural growth of the remaining trees.

The Future of American Forestry. The United States is apparently at the point where it is about to turn from "mining" to "cropping" in the management of its forests. The growing scarcity of lumber which is responsible for this change in management is not old. It is probable that in 1840 almost as much timber was standing as when America was settled The development of the Middle West with the accompanying construction of millions of new wooden houses started the large-scale cutting of the forests. The total production of lumber in 1840 was about one billion board feet, but by 1869 the annual production had passed twelve billion board feet, and in 1907 the output reached the peak of forty-seven billion. Since then production has fluctuated greatly, but the trend has been downward. In 1932 only ten billion board feet were cut and the annual production has not exceeded thirty billion board feet since 1929. Hardwoods have become scarcer and the softwoods have increased in relative importance.

As a result of the growing scarcity of wood, Americans have realized the need for a rational forest policy. In 1891, Congress established forest reserves, especially in the Rocky Mountain and Pacific Northwest areas. Since the passage of the Weeks' Act in 1911, the Federal Government has been building National Forests by purchases in the Great Lakes and Appalachian regions. Thus approximately one-third of the standing saw timber has come under the control of the Federal Government. From this land, the Government permits the annual cutting of approximately one billion board feet of lumber which is only one-sixth the possible yield. State governments also own forest lands, but many of these are inferior areas confiscated for nonpayment of taxes. Town forests in New England obtained in the same way have in many cases been developed into valuable properties.

The whole problem of rational management of forests for the United States is by no means simple, for it involves complications of freight rates, taxation, labor costs, interest rates, competition of more lucra

tive sources of investment, substitutes for wood products, and a host of other factors. But managed forestry promises to become profitable in the near future as the supplies of virgin timber become exhausted.

QUESTIONS FOR DISCUSSION

1. What by-products of forestry may justify the expenditure of government funds on forests when these forests are not commercially profitable?
2. To what extent can wood be replaced by substitutes?
3. Why have business organizations hesitated to plant timber trees as a crop? Make a list of the probable income and expense items which would accrue year by year in a privately owned managed forest

Lumbering and Associated Industries

The United States. This country uses about two-fifths of the world's annual consumption of wood and about half of its annual consumption of wood pulp. The South and the Pacific Northwest export softwoods, and the industrial regions of the Northeast import large quantities of wood pulp and cabinet woods Within the country the forest industries vary greatly from region to region according to local resources and the stage of economic development.

The Northeast. In New England and around the Great Lakes, the production is largely spruce or hemlock for use in paper mills. Some white pine and small amounts of oak, maple, beech, elm, and birch are still cut, but such lumber is insufficient to supply the surrounding area. The demand for wood pulp is so great that many of the mills import it from Canada and Sweden.

The wood pulp paper industry became important in New England and northern New York in the 1880s. The mill locations were selected because of nearness to the spruce forests, adequate water supply for washing, and accessibility to cheap water power for grinding the pulp. With the removal of most of the original spruce forests, the New England paper industry has become interested in growing its own raw materials.

There are several reasons why pulp manufacturers should be among the first of the commercial concerns to embark upon the production of timber as a crop. In the first place, a pulp mill represents a much larger investment than a sawmill, and the pulp manufacturer is reluctant to move to new forest areas if such migration can be avoided. In the United States, the pulp mills have tended to remain in the East and North and import pulp logs rather than follow the forest. In addition, pulp can be made out of relatively young trees so that, if managed forestry is practiced, the owner need not wait so long as the timber grower for a return on his investment. He may harvest a crop oftener and need not, therefore, own so much land as would be necessary if he were "farming" saw timber. The result is an increasing tendency for pulp companies in all parts of the world to operate managed forests with permanent mills, permanent towns, and permanent means of transport.

The Southeast. Here is produced a great variety of forest products including Southern pine, turpentine and rosin, hardwoods, and, in recent years, wood pulp and paper. Most of the hardwoods of the United States are now cut in the Southern Appalachians or on the alluvial soils of the Mississippi Valley. Oak, chestnut, walnut, gum, and yellow poplar are the leading varieties. The sandy soils of the coastal plain are the home of the Southern (yellow) pines which are cut for lumber or used for turpentine. The swampy areas along the coast are important as a source of cypress.

Two recent developments have increased the potentialities of Southern pine forests. First, new chemical processes have made possible the use of Southern pine as a substitute for spruce in the manufacture of wood pulp. This may mean a shift in the paper industry southward since the South has also adequate water and water power. Second, the replanting and careful management of forests is spreading in the Gulf States where the long growing season enables trees to mature in half the time required in New England.

The Pacific Northwest. The Douglas fir in the marine west-coast region is now the leading timber tree of the United States. In this cool, damp region, mature trees may reach 300 feet in height and 15 to 20 feet in diameter. Associated with parts of the Douglas fir area are other valuable timber trees such as the redwood (sequoia), western hemlock, spruce, and cedar.

Modern logging methods have reached their greatest development in the Pacific Northwest. Only the felling and stripping of trees is still done by hand; logs are hauled to the railway or waterway by cables or tractors. Thence they reach the huge, permanent sawmills by rail or in huge rafts, which are floated downstream, or sometimes they are even transported in the open sea. The sawmill is operated by steam or electricity generated by burning sawdust and other scraps from the mill. Mills not only produce boards but a variety of finished products such as doors, window frames, and boxes.

Canada and Alaska. Nearly one-half of Canada is covered by a great northern coniferous forest which also extends across Alaska. While not all of this forest is commercially valuable or served by suitable transportation, much of it consists of excellent pine, spruce, larch, and other conifers, and constitutes the basis for a forest industry which is second only to agriculture as a source of income to Canada. Most of the area still covered by this forest is too cold or has a soil too acid to encourage agricultural use. The situation is much like that in Sweden, and, if similar methods of exploitation of the resources are used, these forests should continue to support a profitable industry indefinitely. At present, however, most of the lumbering operations may be classified as "mining" the forest.

The southern edge of this great forest has, naturally, been subject to the greatest development. There, the timber is of better quality because the climate is milder. Transportation is easier for the same reason, and lumbering may be carried on closer to the markets of the more populous parts of Canada and the United States and closer to the ports for export shipment.

Sweden, Finland, and Norway. The importance of forestry in Sweden has already been pointed out. Finland and Norway are also countries whose principal land resource lies in forest. All have developed careful methods of production, protection, and regrowth to foster a permanent industry. They are all fortunate in that they have the only northern-coniferous-forest areas which lie on navigable waters and close to the European industrial markets. The forest areas of Norway are small compared with those of Sweden; but the forest area of Finland is large, and forestry is so important to the nation that it furnishes nearly four-fifths of all its exports.

U.S.S.R. (Russia). Except for relatively small areas in Scandinavia, Finland, and Manchukuo, the northern coniferous forest in Eurasia lies entirely in Russian territory. Its isolation from markets, both because of distance and the severe climate which makes the rivers of the area of little value for transportation, has, however, prevented this region from making any considerable contribution to the world's production of timber. The increased industrial and commercial development of the Soviets within the past few years has resulted in increased exploitation. The bulk of the population lives to the south of the coniferous forest in the area formerly covered with mixed hard- and softwoods, and much of the timber near the markets has been cleared off. Timber and pulp for export come largely from the coniferous forest north of Leningrad or along rivers flowing into the White Sea.

Germany, Slovakia, Poland, Rumania, and Yugoslavia. These countries include within their borders most of the mountainous regions of central and southern Europe still covered with valuable forests. In most cases the upper slopes yield conifers, while beech, oak, and a few other hardwoods are cut from the lower slopes. The forest industries of these countries roughly resemble those found in the Appalachians, from New England to Alabama. The products include wood pulp, paper, building timber, furniture, and small wooden articles.

Lumbering in the Tropics. Tropical forests contain tremendous quantities of lumber, but they are little exploited. Many tropical forest areas even import lumber from the north temperate zone and leave their own resources almost untouched. The tropical forests thus represent a lumber reserve which contains as much wood as is in the temperate forests.

Why has this huge resource not been tapped? Undoubtedly the disadvantages of an unstimulating climate and poor labor provide an important part of the explanation. But even these handicaps could be overcome if a great demand for tropical woods existed. This is shown by the extensive use of high-priced cabinet woods—mahogany, rosewood, and ebony.

The nature of the tropical forest provides the key to the problem. Unlike the temperate forests, the rainforest may contain a thousand species within a square mile Only a few of these trees are known in world markets and are, therefore, worth shipping. Many of the best trees are so heavy that they will not float and must therefore be hauled overland or by boat to the ports. If a market could be found for most of the trees in a tropical forest area, instead of for only a few cabinet woods, it could be profitably exploited. So far, such conditions have developed only in a few favored and less variegated forest areas.

QUESTIONS FOR DISCUSSION

1. New England paper factories are turning to the production of high-grade paper products (writing paper, artificial leather, etc.)? How might this trend be explained?
2. Tropical cabinet woods lack the rings which are common in temperate zone lumber. Why?
3. How serious is the problem of forest conservation in the United States at the present time? Explain your answer Do you think it likely that all of our privately owned forests will eventually be destroyed?

CHAPTER 16

INTRODUCTION TO AGRICULTURAL GEOGRAPHY

No INDUSTRY is more basic than agriculture. The farmer not only produces most of the world's foodstuffs and many of its industrial raw materials; he is an important market for the goods and services of the city-dweller as well. In the United States the purchases of farm employees—these people represent only one-quarter of all persons employed—often play a much larger part in the economic system than the percentage of the population they represent would indicate. For example.

> It appears that about 4 out of every 10 persons reemployed in urban industry since the spring of 1933 owe the recovery of their jobs to the improvement in the farm situation. Statistical evidence compiled by this Department indicates that shipments of industrial goods to rural areas have increased proportionately with the advance in rural incomes. Farm recovery got under way in 1933 earlier than industrial recovery and maintained its lead in 1934. Urban industry benefited promptly. For example in towns of less than 10,000 population and on farms sales of automobiles in 1934 totaled 833,000, as compared with 602,000 in 1933. This was an increase of 231,000, or 38 per cent. In cities of more than 10,000 population, on the other hand, sales of automobiles in 1934 were 1,055,000, as against 892,000 in 1933, an increase of 163,000 or only 18 per cent [1]

There are few large businesses that can operate efficiently without some understanding of the agricultural situation in the areas in which they produce and market their goods. Too often have sales managers attempted to force sales in rural districts which lacked purchasing power because of low yields or falling prices. Too often has credit been extended when the agricultural prospects did not warrant it. The mail-order houses are well aware of the relevancy to their business of these and other farm problems, and other businesses might profit by their example.

[1] Henry A. Wallace, Secretary of Agriculture, in *Yearbook of Agriculture, 1936*, p. 2.

Agricultural Systems

The farmer has no simple task in adjusting his production to the physical and economic conditions so that he may obtain a profit. Each crop on his land is governed by all, or nearly all, of the following group of environmental influences, many of which are extremely unstable:

I. Atmosphere
   A. Temperatures
      1 Length of growing season
      2. Diurnal variations
      3. Extremes (especially extremely low temperatures)
   B. Moisture
      1. Precipitation form, amount, distribution
      2 Relative humidity
      3. Rate and amount of evaporation
      4. Ground water
   C. Amount and intensity of sunshine
   D. Winds
      1 Strength and steadiness
      2. Direction
      3. Prevalence of destructive storms
   E. Chemical content
      1. Presence of chlorine, carbon dioxide, and other noxious fumes

ANALYSIS OF PLATE IX: TYPES OF AGRICULTURE

IX A. Such level land permits regularly laid out farms with good roads which provide easy access to neighbors and markets.

IX B. In contrast to IX A this farm contains very little level land. Only where the valleys broaden out is farming worth while. There is no road approaching this farm and the gravelly bed of the creek provides the only avenue of transit. Neighbors and markets are both hard to reach; life on such farms must therefore be largely self-sufficient.

IX C. The comfortable farmhouse, kept in good repair, the large, well-constructed barn, the windmill for pumping water, and the lack of gullies are all signs of a well-run farm.

IX D. Modern machinery has taken much of the former drudgery out of farm work.

IX E This is native hoe agriculture in the tropical steppes of west Africa Without a plow or work animals, tremendous labor is necessary to cultivate the soil, especially by dry-farming methods

IX F. Where the population is dense and the soil is rich, the tropical forest climatic region is occupied with a thoroughness which contrasts strikingly with VIII A. The terraces are built sometimes to prevent surface erosion and sometimes to permit the fields to be used for rice. Note the modern road and the well-built homesteads along the road

II. Topography
   A. Altitude (effect on temperature, precipitation, etc.)
   B. Barrier effect (wind shelter, seed dispersal, etc.)
   C. Structure (effect on drainage, etc.)
   D. Slope (surface drainage, erosion, frost drainage, etc.)

III. Soil
   A. Physical structure
      1. Root room (cracks, size of particles)
      2. Depth
      3. Horizontal structure
   B. Aeration
   C. Water supply
      1. Capacity
      2. Drainage
      3. Circulation (ground water, capillary movement)
      4. Precipitation and evaporation
   D. Soil life
   E. Soil temperature
   F. Plant nutrients (organic and inorganic)

IV. Life
   A. Plants
      1. Competition of other plants
      2. Diseases
      3. Parasitic plants
      4. Addition of humus to soil
   B. Animals
      1. Parasitic animals (including man and pests)
      2. Seed distribution
      3. Addition of manure and corpses to soil
      4. Distinctive properties of man
         a. A selector and propagator of plants and animals
         b. A modifier of the environment

In addition to the numerous physical conditions outlined above, the farmer must also consider a variety of economic factors, most of which are equally unstable. Indeed the economic factors are often more unstable because of the many controls, both at home and abroad, which influence them. Among the economic factors are:

A. Cost of land and equipment
   1. Purchase price or rent capitalized
   2. Purchase price of machinery

B. Operating expenses
   1. Cost of seed and fertilizers
   2. Cost of labor
   3. Cost of power (or feed for draft animals)
   4. Interest on mortgages, loans, and installment purchases
   5. Taxes
   6. Allowance for depreciation
   7. Costs of meeting such emergencies as drought, pests, and plant and animal diseases

C. Marketing expenses
   1. Freight-rates and trucking charges
   2. Storage charges and wholesalers' commissions
   3. Spoilage en route to the market

D. Market conditions
   1. Supply in United States and foreign markets as influenced by tariffs, subsidies, etc.
   2. Demand in United States and foreign markets as affected by tariffs, business conditions, etc.

Not only must the farmer try to adjust his agricultural system to this multitude[1] of changing influences, but he must foresee adjustments that will be necessary when his product is ready for sale, weeks, months or even years after he commences to produce it.

How Systems of Agriculture Are Developed. In agriculture, as in every other human activity, there are two dominant, interrelating factors—the nature of man's ideas and the nature of the physical environment. The nature of man's ideas—his inherited techniques and his experiments—determines what he will try to do, and the physical environment largely sets the limits which determine whether the proposed course is a possible one.

Imagine a farmer from the tropical forest lands transplanted to the type of environment which existed in the Middle West of the United States before the coming of the white man! In his former home this farmer was accustomed to raising a few banana plants and a few rows of beans, yams, and taro. These, together with what he was able to gather in wild products from the forest, served to feed his family. His first attempts at agriculture in his new home would be similar to those to which he was accustomed in the old. This would be inevitable because they are all that he knows. The experience of one year would teach him that all of the plants that he knows are excluded by the climate. The result might well be starvation and death in an environment that is destined to be considered among the best in the world for agriculture.

It is more probable that the immigrant will examine the systems used by the native Indians and adopt them rapidly. He has assurance that these systems will work in this environment because they have helped to support these same Indians for generations. He learns to use new crops and new methods which have been tried in this environment and found satisfactory. Perhaps he has developed some practice in his old home which is perfectly satisfactory in the new. Perhaps also it is entirely different from any used by the natives and is, in fact, an improvement on them. In these ways the coming of a stranger may not only modify his agricultural methods but may change the whole system of agriculture in the region.

To a migrant from a region whose environment is similar in many ways to that in the Middle West, the result of the interchange of ideas may be even

[1] Although the lists of economic and environmental influences are long, they are probably far from complete.

more important. Imagine the farmer of Elizabethan England transported to the forest clearings of what is now Indiana with all his tools, seeds, and domestic animals. He would find that his wheat, cabbages, hay, rye, oats, and turnips would thrive in the new conditions and that his cattle, sheep, pigs, and fowl, with some added provision for shelter, would flourish. All of these things would be new to the Indian farmers and they would eventually learn from him how to use them. In addition, they would have crops which would be new to the Englishman Corn, pumpkins, and tobacco would be welcome additions to his list of crops—especially corn, which would prove to be the best cattle feed he has ever known. Because of the fusion of cultures, a new and better adjustment to the old environment would spring up.

The whole process of adjustment is by no means simple. The environment is, in most cases, the element which changes least rapidly—although it, too, may change. The elements varying most rapidly are those included in the culture of the people. They have been summarized by a leading agricultural economist[1] approximately as follows:

CULTURAL CONDITIONS DETERMINING SYSTEMS OF FARMING

1. Influence of legal systems (especially systems of land tenure)
2. Influence of ratio of population to land
3. Influence of marketing systems
4. Cost of transport and marketing
5. The technique of farming (*i.e.*, what man has learned about methods and crops)
6. Competition or interdependence of enterprises
7. General level of intelligence of the population
8. Abundance of capital
9. Inertia of an established system
10. Tariffs, subsidies, and other artificial influences

QUESTIONS FOR DISCUSSION

1. How might the system of land ownership affect the nature of the agricultural system?
2. How may government activities influence the system of agriculture prevailing in a nation?

Three Major Agricultural Systems

Self-sufficient Agriculture. In regions where the farmer is isolated from his neighbors by barriers or by distance, where transport is poor or nonexistent, or where an exchange economy has not developed for cultural reasons, he attempts to meet all of his needs from the local environment. He must work out a system of farming which will supply him with food throughout the year and also provide such of the materials of his clothing and shelter as are not supplied by the wild animals of his environment or the native vegetation. His fundamental wants are similar in most environments—the exact materials he uses to satisfy them in any specific region are dependent on the state of his knowledge and what the environment permits or encourages.

This type of agriculture in its purest form is probably not very widespread today There are, however, hundreds of millions of farmers in Asia who are *relatively* self-sufficient. They occupy land which is excellent in its site qualities, as indeed it must be if it is to supply, from a small area, all of its inhabitants' needs. Poor position or cultural conservatism has prevented this good land from entering into world trade to any important extent. Even the position factor is not so much a matter of great distances as it is of high costs of marketing due to poor transportation and unstable government. The conservatism of the Asiatic masses also tends to perpetuate a well-established system which is closely tied up with religion and family customs.

One of the reasons for the decrease of self-sufficient agriculture is that it can provide only a low standard of living. The self-sufficient farmer must be satisfied with homemade clothes, little variety in foods, and a total lack of the luxuries which result from large-scale manufacturing and the division of labor.

One-crop Agriculture. This system has developed mainly in the past century—a span of history which has seen the rise of that modern transportation and that highly developed exchange economy which make such a system possible. The farmers of the American Cotton Belt, or the Argentine grain regions, can now specialize on the products for which their culture and environment appear best suited and exchange their products in distant markets for goods from all the world. So much has been said in recent years of the disadvantages of one-crop agriculture that its geographic and economic bases need to be analyzed.

It would seem axiomatic that everyone would be better off if each commodity were produced in the places where the combination of the cultural achievement and the physical environment allowed it to be produced most efficiently. With perfect freedom of trade, such a system should result in the widest variety of high quality goods being available to the world's peoples at the lowest possible price. Applying this system to the individual farmer, he could raise

[1] L. C. Gray, *Introduction to Agricultural Economics*, p. 6. Macmillan, New York, 1929.

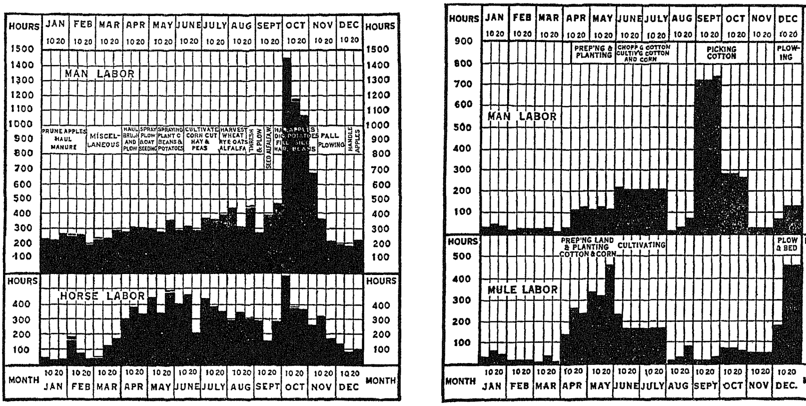


Figure 84. The diagram to the left shows the seasonal distribution of labor on a 256-acre diversified farm in western New York State. In the year used as an example, 40 acres were in apples, 2 in pears, 48 in hay, 26 in wheat, 19 in beans, 15 in peas, 12 in corn for silage, 9 in rye, 7 in potatoes, 7 in pasture, and one-half acre in vegetables Considerable extra help was hired during the apple-picking season. The diagram to the right shows the seasonal distribution of labor on a 160-acre cotton farm in the Black Waxy region of Texas. 117 acres were planted in cotton This is as near to one-crop farming as is commonly found. Except during the picking season, the farmer and his three sons did all the work. (Diagrams and data from *Yearbook of the Department of Agriculture, 1917*)

the crop which would give him the largest return from the land, labor, and capital used.

The one-crop system has, however, several weaknesses. It requires uninterrupted transport and trade; and these are by no means always available. Wars, blockades, tariffs, and embargoes interrupt the free flow of goods and have had disastrous consequences in the past. For this reason, and others, there has been a tendency in the reverse direction and many nations have desired to become as self-sufficient *nationally* as possible. This has led some to discourage dependence on foreign goods and to encourage home industries and home markets through tariffs, embargoes, and bounties. This policy on the part of several European nations has led to the development of the beet-sugar industry at the expense of the one-crop sugar-cane growers of the tropics.

Even within national boundaries, the one-crop farmer is often in a precarious position. Costs such as interest and freight rates are relatively fixed, yet many factors may cause his income to vary and most of them are entirely beyond his control Loss results if the demand is changed because:

1. The demand for his product decreases due to substitutes or changes in fashions. This has happened to the cotton farmer.
2. The principal buyers of his product have suffered a decline in income.

Loss may also result from a change in supply because:

1. The weather conditions have been exceptionally good and there has been too large a crop, resulting in low prices.
2. Weather or pests destroy his one crop
3. New and competing producing districts arise

In addition to the disadvantages connected with the sale of his crop, there are others. The continual growing of one crop on the same field wears out the soil. This results either in the abandonment of the land or increasing cost for fertilizer. If few animals are kept, as is usual in one-crop farming, manure is scarce, and expensive commercial fertilizers become a necessity. Because only one crop is grown, there is often a short season of intensive demand for labor and machinery for which there is no use the remainder of the year. The idle time as well as the busy time must be charged against the single crop.

There are probably few farms which are devoted, exclusively, to one crop. Over large areas, however, there is a preponderance of one crop and, to the extent that this is so, all the disadvantages discussed above are present. It must not be concluded from

the above that one-crop farming is always disadvantageous. If the farmer can know his market well enough and make changes from one specialty to another, in time, he may continue to be prosperous, but the risks are almost always greater than on the mixed farm.

Extensive Agriculture. Most but by no means all one-crop farming is carried on by extensive methods. This involves the use of large areas of land and of relatively small amounts of labor and capital. The total amount of labor and capital used *per farm* may be large but the amount *per acre* will be low. Likewise the crop yield per acre and the income received per acre will be very low.

Extensive Agriculture and Machinery. Large areas of land and small supplies of labor, as in the United States, favor the development and use of agricultural machinery The scarce element of production in American economy has been, until recently, labor. Capital has been relatively abundant and the most economical combination has been that of large areas of land, worked by machinery, with the use of as little labor as possible. Such a system is admirably suited to the production of wheat in the drier or more remote areas where land is cheap. Wheat is, also, a crop which can be handled largely by mechanical methods. Its planting is a simple process, it requires no cultivation, and it all ripens at one time so one harvest of the uniform product may be achieved. Many crops, such as corn or tobacco, which are planted in regular rows may be cultivated by machinery.

Considerable areas of flat land are necessary if machinery is to be profitably used in preparing the soil. The economy in plowing and harrowing by machine lies in the ability to proceed for considerable distance in one direction without turning. The necessity of relatively flat land for the use of agricultural machinery has had an important effect on its distribution. It has been most successful in plains regions such as the American Middle West, the Argentine, Australia, and Russia.

Rugged regions, because of the small size of the fields and the steep slopes, seldom see much development of machine agriculture. In addition, the relative poverty of the inhabitants, because of the poor environment and isolation, usually prevents the accumulation of the capital to purchase the machinery.

Many crops, such as cotton and fruit, do not lend themselves to machine harvesting, because all units do not ripen at the same time and human judgment

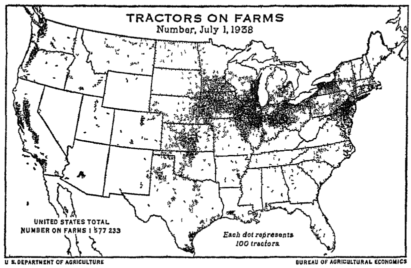


Figure 85. Note how few tractors are found in the South.

must be used to determine which is ripe and which must be picked later.

Some machinery may be used with intensive agriculture, but the most highly mechanized farms are generally those with an abundance of land. In regions of intensive farming, labor may be cheap and capital may be scarce—both factors discourage the use of labor-saving machinery Furthermore, when plants are planted close together, it is not possible to use machines between the rows. Nor has any machine been devised which will distinguish between weeds and cultivated plants or between ripe fruits and immature fruits.

Mixed or Diversified Agriculture. This type is intermediate between the self-sufficient and the one-crop types. In it, the farmer raises some of his own food in his garden and orchard, a variety of field crops, and usually maintains animals for meat, milk, and manure. This is the common type in much of the moister part of Europe and in the northern and eastern parts of the United States. In the South it is fast replacing the one-crop cotton system which formerly prevailed there.

Mixed farming does not produce the high returns which come to the one-crop farmer in those fortunate years when every unit of his one crop commands a high price. However, a fairly steady income is much more certain in diversified than in one-crop agriculture. The advantages accruing to the operator of a diversified farm are largely the converse of the weaknesses in the position of the one-crop farmer. They may be summarized as follows:

1. He has a variety of sources of income, all of which are not likely to suffer from low prices at the same time.
2. He produces some of his own food.
3. The demand on his labor and machinery is spread more evenly throughout the year.

4. He may practice crop rotation because he normally raises a variety of crops
5. His animals refine the crops of the farm into their most concentrated form for sale and return the wastes to the land as manure.

Limitations on Mixed Farming. The preceding discussion seems to suggest that mixed farming is so superior to one-crop farming that few farmers would continue under the former system. Mixed farming, however, has such a variety of environmental, economic, and social requirements that there are but limited areas of the world and limited numbers of its people that fulfill them

If the operator of a mixed farm is to raise a variety of crops and animals, he must live in an environment which is favorable to all of these activities. Every crop in the system has requirements of soil, climate, or growing season which are slightly different from those of the other plants. The environment must fit, not just one, but all of the crops. This, alone, eliminates much of the world's area from the possession of such a system. If the farmer is to keep animals, additional qualifications further limit the land available.

The above are strictly environmental limitations; there are also economic ones. Such a farm must be relatively near markets for all of its products. The markets which will absorb all of them are limited. Transportation must be easily available and must be relatively cheap.

There are also limitations of culture. Both a high intelligence and a knowledge of a wide variety of agricultural techniques are required to operate such a farm. A relatively poor quality of human being, or one with little knowledge, may learn enough to succeed on a one-crop farm in favorable times. It requires a rather high type with a diversity of knowledge and skills to be a really qualified operator of a mixed farm. The limited number of such people is a further limitation on the spread of diversified farming.

Intensive Agriculture (Cultivation). Intensive methods, that is, the use of relatively *large* amounts of labor, or capital and labor, on a relatively *small* area of land, are common in both diversified and self-sufficient agriculture. They are also used in highly specialized types of one-crop agriculture such as fruit-growing, dairy-farming, and market gardening.

Intensive agriculture is most common where land is relatively scarce. This scarcity may be due to a dense population—as in China, Japan, Java, Belgium, and the Netherlands. In areas near large cities, intensive cultivation is necessary because the farmers must compete with industrial, commercial, or residential users of the land. In Monsoon Asia, where arable land is especially scarce, intensive agriculture involves continuous, backbreaking labor in order to wrest a bare existence from an unbelievably small area by use of the simplest of tools.

QUESTIONS FOR DISCUSSION

1. Would it be logical to expect a greater diversification of agriculture in a region having twenty inches of annual average rainfall or in one having forty inches? Why?
2. Is one-crop or diversified agriculture likely to be more advantageous as a long-time practice? Why?
3. How might the distribution of the climate suited to the highest physical and mental energy of human beings have an effect on the distribution of mixed farming?
4. What factors have made one-crop farming possible?

The Problems of the Farmer

The city-dweller often regards the farmer as an odd mixture of the radical and conservative. The farmer is often radical in his economic and political ideas, but conservative in his agricultural techniques and social customs. The conservatism arises from the fact that it has taken centuries to accumulate the knowledge and techniques now used in agriculture The knowledge and skill required to operate a diversified farm can probably be acquired only by growing up in the business. The practices learned are those which experience has demonstrated to be best for the crops raised in that environment. The "dirt farmer" is often reluctant to believe that a stranger who has never gone through the same apprenticeship can tell him how to improve his methods.

The farmer's political and economic radicalism is also closely related to his farm problems. During his farm career, he may fail to make a living or be unable to pay his taxes or the interest on his mortgage because of drought, pests, or other mishaps which are, in no way, his fault. Again he may invest his funds in raising a crop only to find that, because of some shift in foreign markets or the manipulation of speculators, his harvest does not bring enough to pay his costs. Under such circumstances, the farmer's natural reaction is to expect his government to assist him.

It is often assumed that the farmer has a greater degree of economic security than the industrial laborer, the clerk, the manufacturer, or the trader. To some extent this is true. If environmental conditions are favorable, the farmer may produce much of

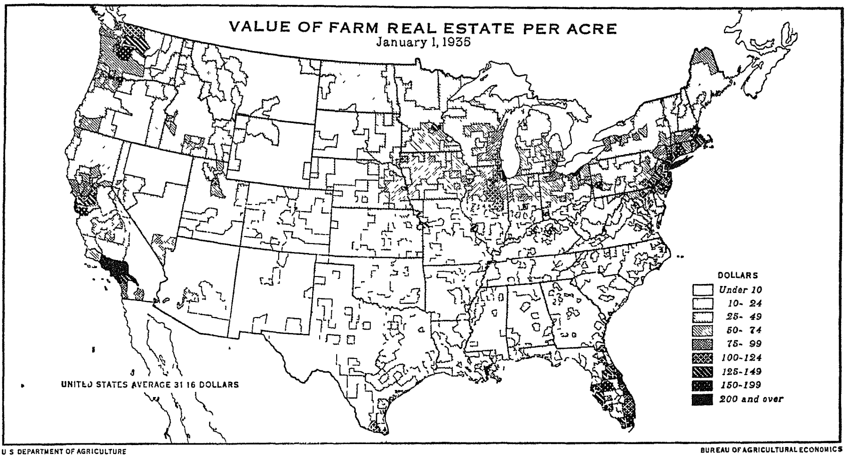


Figure 86 Note the influence of proximity to large cities, length of growing season, and prevalence of irrigated farming.

his food, even in periods of economic stress. But, as was indicated in the description of self-sufficient agriculture, on the average, the greater the degree of self-sufficiency, the lower the standard of living. In most parts of the world, today, the farmer is not a producer of goods that will satisfy all of his wants, directly. He is forced to market crops and to buy clothing, tools, machinery, seeds, and often fertilizer and much of his food. He has to pay taxes and interest on his borrowed capital. Most farmers are almost as subject to the fluctuations of the market as the manufacturer or the laborer. Prices received for his products fluctuate, as do also the prices he pays for the goods he must buy. In addition, the elements of the physical environment affect him more directly than they do his fellows in the city. He not only gambles on market prices as does everyone else, but he also gambles on weather, insects, and diseases.

Agriculture—an Industry of Increasing Costs. Many industries such as manufacturing are carried on under conditions of decreasing costs, that is, larger production is usually accompanied by a decreasing cost per unit. In agriculture and several other industries closely connected with the land resources—such as mining and lumbering—conditions are reversed and additional production generally means increasing costs per unit. This is true because additional resources are drawn upon and, since the land used at first is usually the best land, the expansion of production usually occurs on inferior lands.

The expansion of production on inferior lands cannot continue indefinitely. Beyond the physical *limits* (*i.e.*, land having the minimum physical conditions for a crop) production, under ordinary agricultural conditions,[1] is impossible. However, land just barely within a crop's physical limits is rarely used for that crop. More important than the limits is the *margin*, or *marginal land*—land which has the minimum conditions for *profitable* production. Such land is sometimes described as being on the *extensive margin of cultivation.* The farmer who occupies such land (the *marginal producer*) just manages to cover his costs of cultivation and transportation to the market. Land inferior to this is *submarginal* and should not ordinarily be used. However, in a period of falling prices, land formerly within the economic margin becomes submarginal and the farmer may continue in production because he cannot afford to allow his investment in the buildings, stock, and machinery to lie idle, nor can he liquidate this investment. Temporarily farmers can continue to produce under submarginal

[1] Production is not *absolutely* impossible beyond the limits. For example, if irrigation, fertilization, heating, and sunray lamps were used, it might be possible to grow rubber trees within the polar regions.

conditions by lowering their standard of living, failing to maintain the fertility of their soil, or failing to pay taxes and interest.

The Law of Diminishing Returns. Agricultural output may be increased by more intensive cultivation of existing farm lands rather than by areal expansion. In many ways this is advantageous, for it saves the costs of clearing new lands and of occupying sites which are inferior in position. However, after a certain point has been reached, further intensification results in a greater *total* return but a smaller return *per unit of capital and labor* invested. This point is known as *the point of diminishing returns.* The decrease in yield per unit in spite of the increase in the amount of labor or capital used from this point on is due to many physical factors. Chief among them are:

1. *Area.* Men and animals may be so crowded at times of planting, harvest, and cultivation as to interfere with efficiency. Plants may be so crowded that they interfere with harvesting or cultivation.
2. *The rate at which the soil makes plant food available.* While this may be increased somewhat, it is relatively stable and, once the point of maximum efficiency is reached, additional fertilizer will not be made available to plants rapidly enough to increase yield proportionately.

It may be profitable to continue cultivation beyond the point of diminishing returns because the additional product received from the land exceeds the capital and labor invested. Eventually, however, intensification of cultivation reaches a point beyond which the additional investment of one dollar in labor, machinery, and fertilizer will yield less than one dollar in additional produce. This point is called the point of most profitable use and occurs at both the intensive and extensive margins of cultivation.

Finding the Extensive and Intensive Margins. A simple table (Fig. 87) based on imaginary but not improbable data will illustrate these principles. For sake of analysis, it is necessary to assume that the costs shown in the table are fixed, that all the land is equally accessible to the market, and that all the farmers know exactly how to work their land so as to produce the amounts listed in the table. Rarely do the facts fit all these assumptions, but such assumptions, nevertheless, do not invalidate the principles illustrated by an analysis of Fig. 87.

According to Fig. 87, if the price of corn were ever to fall as low as 15 cents per bushel, only the optimum and second-grade land could be profitably used for corn. The extensive margin would therefore be the boundary between the second- and third-grade lands. The intensive margin would be at forty bushels per acre on the optimum land and at twenty bushels per acre on the second-grade land. Should the price increase to 20 cents per bushel, the third-grade land would be brought within the extensive margin. The intensive margin would then be at fifty bushels on the optimum land, at thirty bushels on the second-grade land, and at ten bushels on the third-grade land.

Let us assume now that the optimum land is further away from the market than the other grades of land. If the effect of this greater distance is to increase the freight-rate 5 cents per bushel, then the costs on the optimum [1] land must be increased cor-

[1] *Optimum* as used in geography and biology refers only to the site aspects of the land, especially soil and climate. Economists often use the term *optimum land* to describe the land with the greatest yield per acre under a given set of economic conditions. Thus second-grade land located close to the market might be (economically speaking) optimum land because low marketing costs made intensive cultivation profitable.

Figure 87

A HYPOTHETICAL EXAMPLE OF THE COST OF PRODUCING AND SHIPPING TO MARKET A BUSHEL OF CORN ON VARIOUS GRADES OF LAND

Total bushels produced		*Cost per bushel on each grade of land*					
		Optimum	*Second-grade*	*Third-grade*	*Fourth-grade*	*Fifth-grade*	*Limits*
10	First 10 bu.	$ 10	$.15	$ 20	$.25	$ .45	$ .60
20	Second 10 bu.	.10	.15	.25	.35	.60	2.50
30	Third 10 bu.	.10	.20	.30	55	1 00	*
40	Fourth 10 bu.	.15	.25	.40	.65	1.50	*
50	Fifth 10 bu.	20	30	.55	1.00	*	*
60	Sixth 10 bu.	.25	.40	.75	1.50	*	*
70	Seventh 10 bu.	.35	.55	1.00	*	*	*

* Production of such high yields almost impossible on this land.

respondingly. Thus if the price of corn were 15 cents, the intensive margin would be at thirty bushels per acre on the optimum land, but would remain at twenty bushels on the second-grade land.

A striking example of such relocation of the economic margins occurred in the United States and Canada during the World War. The demand for wheat increased tremendously and the price jumped in response to the increased demand Farmers within the old margin intensified their agriculture until the new intensive margin of cultivation was reached. Much land that was within the physical limits for wheat, but was formerly submarginal (due to distance from market or low yield), was utilized; and both the total acreage and the yield per acre (in the old lands) were increased. This agricultural boom collapsed when the abnormal wartime prices were deflated. Many farmers found that they were occupying what was now submarginal land. Banks that held mortgages on this land failed and states were unable to collect taxes. American agriculture has not yet recovered from the crisis due to the bursting of the war boom.

The Role of Geography in Economic Rent. *Economic rent* [1] is the share of the product which may be attributed to land. Its value may be computed as the value of the product less the cost of the capital and labor used to produce it. Since different grades of land vary in productivity (because of differences in site and position), the phenomenon of *differential rent* arises.

Marginal land produces no return above the costs of labor and capital; it is *no-rent* land Land of a higher-grade (that is, having better soil, more fruitful climate, or greater proximity to the market) produces a greater return if cultivated with the same amount of labor and capital. This extra or differential return is the economic rent of the higher-grade land.

For example, if marginal land, cultivated with a certain amount of labor and capital, produces 10 bushels of corn per acre while higher-grade land, cultivated with the same amount of labor and capital, produces 50 bushels per acre, the rent of the higher-grade land is 40 bushels of corn. If the price of corn at both places is 30 cents per bushel, the economic rent of an acre of the higher-grade land will be $12 per year.

World Prices and Local Prices. The local price of all farm goods that enter into world trade is usually based on the price at the principal market for that commodity. If the local market is in a region where a surplus of that commodity is produced, the price is usually the price at the principal market *less* the cost of shipment (including freight, insurance, and commissions) to that market. On the other hand, if there is a deficit within the local region, the price is likely to be the market price *plus* the cost of shipment from the market. For example, the local price of cotton is usually determined by the price at Liverpool, the principal cotton market. The United States produces a surplus of cotton, consequently the price of cotton at New Orleans is usually the Liverpool price less the transportation and other charges represented in marketing the surplus in Liverpool. In Sweden—where cotton must be obtained from Liverpool or some distant center—the price is usually the Liverpool price plus the freight from Liverpool.

The Instability of Comparative Costs. Farmers in various parts of the world produce staple crops at varying costs. This fact is the principal basis of regional specialization (the geographical division of labor) Unfortunately the comparative cost of production in the various regions is not stable, for climatic fluctuations, changes in taxation, wages, tariffs, currencies, and freight rates upset the equilibrium. Such changes are especially frequent in times of agricultural crisis—such as the period following the World War. A change in the comparative cost of production upsets rents and land prices based on economic rent. These changes in costs and world prices are beyond the control of the farmer and, in an exporting country, largely beyond the control of his government. In an importing country, the effects of such changes can be largely prevented, for protective tariffs can keep the local price far above the world price.

QUESTIONS FOR DISCUSSION

1. To what extent is the price of farm products determined by the cost of production? In a small isolated region with no agricultural exports, would the local agricultural prices tend to equal the cost of production? In an exchange economy, is it practicable for the government to guarantee the farmer his cost of production?
2. Look up (in the business section of the *New York Times* or other newspapers) the price of cotton at Liverpool, New York, New Orleans, and Houston. Explain the differences.
3. How does each of the following influence the price received by the American farmer in the case of crops which we export in large quantities?
   a. changes in European tariffs
   b. United States protective tariff
   c. decrease in ocean freight rates

[1] The term *rent* as commonly used by the businessman includes interest, taxes, depreciation, and many other charges which the economist does not consider as a part of economic rent.

CHAPTER 17

VEGETABLES, FRUIT, AND THE MARKET

It would not have astonished the ancients to have heard of the importation of grains from distant lands—such trade has existed since ancient Greece imported much of its wheat from southern Russia; but our forefathers would have been surprised to find such commodities as Danish eggs, New Zealand butter, Argentine beef, and California grapes for sale as far from their points of origin as the New York markets. Such perishable products have only entered into international trade during the last century. The development of this trade can be traced to three revolutionary inventions: refrigeration, canning, and cheap, high-speed transportation. The cost of these improvements is great, however, and a large part of the world's supply of perishable foods is still raised near the market Hence, these industries serve as an excellent example of the influence of market factors in agricultural geography.

In numerous cases the proximity of the market suffices to cause perishable products to be produced near their climatic and soil *limits* rather than under optimum conditions. In a few instances the pull of the market has been so strong that man has artificially reproduced certain physical conditions so as to permit production in regions outside of the natural limits. Hothouses and cold frames are examples of this. But, as the costs of transportation and preservation are reduced, the regions with optimum conditions are conquering an increasing share of the world's markets, and site is gaining predominance over position as a locating factor.

Vegetables

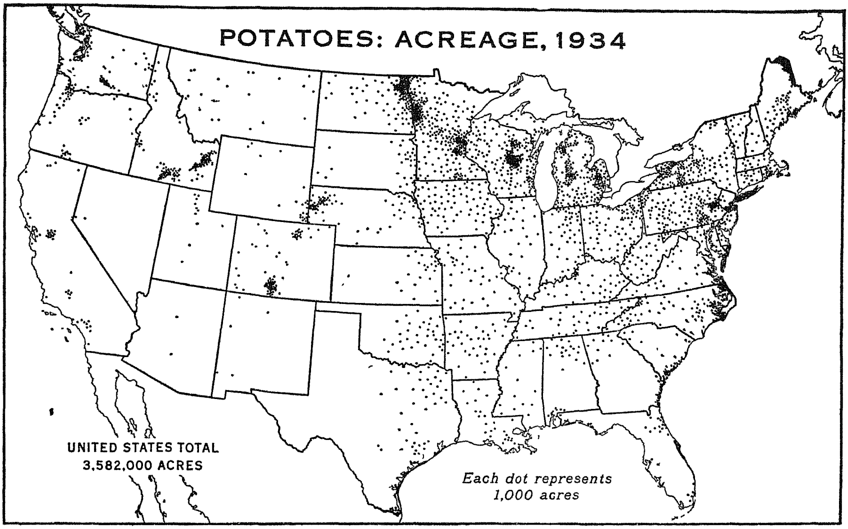
Vegetables play an important part in keeping the diet balanced. Some of them—such as beans and peas—add protein to the diet; others—such as potatoes—add starch and water. In general, they add bulk to the diet and tend to dilute the highly concentrated foods obtained in meats and cereals. Their importance has been further emphasized by recent discoveries which show that they provide most of the vitamins which seem to be necessary for human health.

Vegetables are not so exacting in their requirements for production as many of the grains. Usually they are intensively cultivated, and this often overcomes poor soil conditions and other natural handicaps. Such concentrated labor pays well in vegetable raising, for it results in a tremendous yield, while a similar application of labor to cereals would not increase the yield enough to justify the extra expense. For this reason vegetables are usually raised where a large supply of relatively cheap labor is available, while cereals, other than rice, are more common in areas of lower population density.

There are so many vegetables that almost any environment except the cold or dry deserts will grow some of them. Many of them grow rapidly; thus they may be used where the growing season is short, or more than one crop may be grown in one season. Many of them have been carried far from their original home and have become acclimated to new conditions. Others are being constantly sought for and developed by the agricultural scientists of many countries. Our children will probably relish many vegetables that are as little known to us as the tomato and the potato were to Chaucer.

The Potato. The white potato was apparently first utilized by the Indians of Peru and Bolivia who found it growing wild on the slopes of the Andes. The Spanish conquistadors carried it to Europe, and today the value of the European potato crop is greater than that of all the gold the Spaniards took from the Incas. Now the descendants of the humble Peruvian potato provide food for the Irish and feed for their stock; food, pig feed, and a source of industrial alcohol for the Germans; and one of the principal starch foods in nearly all temperate lands occupied by the white race.

This vegetable has added considerably to man's ability to obtain a living from the earth, for it will grow in lands too cold for corn and on soils too poor for cereals such as wheat. Since these conditions are present in large parts of northwestern Europe, the



U. S. DEPARTMENT OF AGRICULTURE BUREAU OF AGRICULTURAL ECONOMICS

Figure 88 The rich soils of the Red River Valley (North Dakota and Minnesota), formerly devoted to wheat, are now producing potatoes because of the low price of wheat.

potato is much more important there than in America. However, the potato is found in most farm gardens throughout northern United States and Europe north of the Alps, for it is unusually productive and yields five or six times as many bushels per acre as wheat. Potatoes tolerate a wide variety of conditions, but their growth is difficult in warm regions of clayey, poorly drained soil.

Potatoes differ greatly in yield according to the amount of labor and fertilizer used. In Europe where the climate is near the optimum, two hundred bushels per acre is a common yield, while in the United States the average yield is less than half as much. To obtain the maximum yield a tremendous amount of labor must be spent in preparing the seed, in hoeing and weeding, in applying fertilizers, in spraying the plants to kill insects and blights, and in harvesting. In the United States, farmers are unwilling to invest so much labor in the crop unless there is a good market near by.

United States. The potato is very bulky in proportion to its value, so it is unusual to transport it long distances. The farmer who is located away from the market must deduct high freight charges and losses from spoilage from the market price, and these deductions soon eliminate the possibility of profits. Figure 88 illustrates the close tie of the potato farmer to the urban market.

Those centers which are far from the cities must have good sites. For example, Aroostook County, Maine, has a moist, cool climate and a sandy-loam glacial soil formed from limestone and calcareous shales. Although this soil is a podzol, its excellent structure justifies the heavy fertilization which produces record yields. At first, the potatoes in this region were used only for local consumption, and production was small because transportation to distant markets was expensive. In 1874, a starch industry was established, because starch, being only one-sixth as heavy as the potatoes from which it is extracted, could be transported and marketed profitably. By the end of the nineteenth century, a railway connected northern Maine with the New England urban markets and, today, Aroostook potatoes are in demand for starch, for cooking, and as a principal American supply of high-grade seed potatoes. Other examples

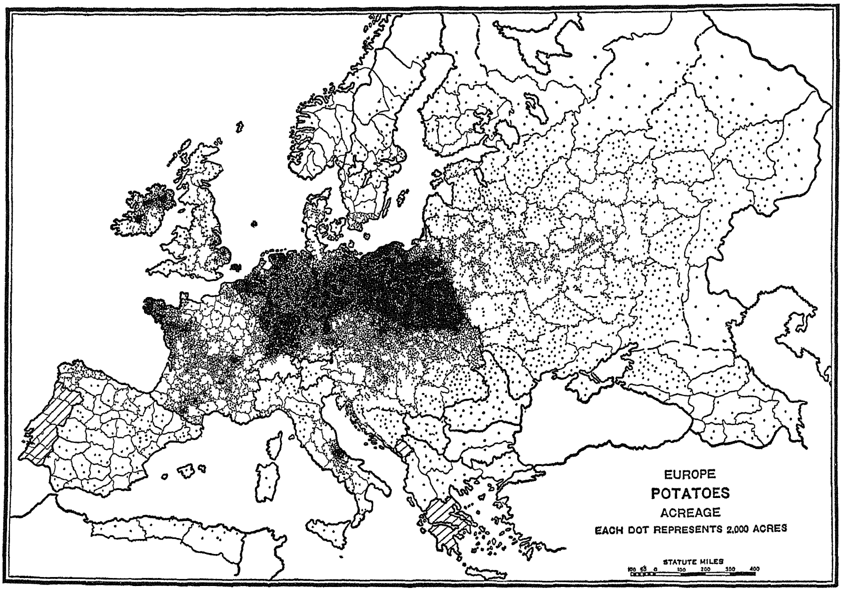


Figure 89 (From Finch and Baker, *Geography of the World's Agriculture*)

of potatoes being shipped to distant markets are: (1) the high-grade, mealy potatoes raised in the cool, irrigated valleys of the Rockies (in Idaho and Colorado), which are shipped to the luxury markets throughout the United States; (2) potatoes shipped from warmer latitudes during the spring and winter (as from Cuba, Florida, and Bermuda); and (3) potatoes shipped to the tropics for white residents who are accustomed to them. But these shipments, although large, are but a small part of the whole American potato industry.

Europe. The European potato map is not so spotty as that of the United States, not only because the urban centers are more closely packed, but because potatoes are more widely used. In Germany, for example, only one-third of the crop is used for human consumption; one-tenth is used for the manufacture of starch, alcohol, and flour; while most of the rest is used as feed for swine. The marine west-coast climate which predominates in northwestern Europe is the optimum for the potato, especially if it is associated with well-drained sandy-loam soils such as are found so commonly on the plains from the British Isles to central Russia. The introduction of the potato revolutionized the agriculture of Europe in much the same way that corn revolutionized the farming system of European settlers in America.[1] In fact, the place of the potato in north European agriculture is strikingly analogous to the place of corn in the American Corn Belt.

Where the soil is unusually good, cereals tend to displace the potato in European agriculture—as in Normandy and the Po Valley. On the other hand, where potatoes are raised in large quantities in the midst of a generally good cereal region, it is often because there is a local area of unusually cool, damp climate—as in the central plateau of France and in

[1] "Potatoes produce a greater amount of food per acre than other staple crops except corn, 100 bushels of potatoes (an average per acre in the United States) having a fuel value of 2,310,000 calories, as compared with 2,340,000 for 27 bushels of corn (an average yield), and 1,430,000 for 16 bushels of wheat. In protein, however, potatoes are deficient, producing only about half as much per acre as corn or two-thirds as much as wheat." V. C. Finch and O. E. Baker, *Geography of the World's Agriculture*, p. 66. Government Printing Office, Washington, 1917.

Brittany. Potatoes are also raised in southern Europe and northern Africa for the winter vegetable trade.

Sweet Potatoes and Yams. In those sections too warm for the growth of the white potato, the sweet potato (botanically unrelated to the white potato) often replaces it in the human diet. A relatively light soil, preferably sandy, with at least a moderate rainfall will suffice to support the sweet potato from the equator to 40° N. or S. latitude. In many parts of the tropics, the sweet potato is used as a crop in rotation with sugar cane. Very similar to the sweet potato is the yam which, however, grows only in tropical and subtropical regions.

Cassava (Manioc). Cassava can be grown in the moderately moist parts of the tropics and in very warm temperate areas, such as Florida. It is a small shrubby plant which occurs in two varieties—sweet and bitter. Both contain a deadly poison (prussic acid). The roots of the plant are thick and full of starch, and by boiling and thorough washing their poison can be easily removed. Cassava quickly exhausts the soil, but otherwise it is not a hard plant to cultivate. It was first cultivated by the Indians of the Amazon Valley and was the most important plant in their nomadic hoe agriculture. Its roots may be boiled or baked like potatoes. The roots may also be prepared and used instead of corn to fatten hogs and cattle. Commercially, cassava is most important as a source of starch and tapioca. It is grown throughout the tropics, but Brazil and British Malaya are the only important exporters.

QUESTIONS FOR DISCUSSION

1. State concisely the present relative importance of site and position in the vegetable industry.
2. Why are so few of the *possible* vegetable-producing areas, actually, large producers?
3. Why is there so little international trade in potatoes and similar root crops? Why is the potato most important in Europe and North America?

Peas and Beans. In America peas and beans are commonly thought of as vegetables which add variety to the diet. They provide protein, but since most Americans receive sufficient protein from the meat they consume, additional protein is not a necessity. In poorer lands the common man cannot afford meat, so peas and beans—which form an excellent meat substitute—are one of the mainstays of the diet. Peas generally perform this function in the cooler climates, while beans almost replace them in the tropics.

Beans and peas may be dried or canned and shipped long distances with ease. For this reason, special centers of production have developed far from the market where climate and other conditions are favorable. However, many people prefer to use fresh vegetables, and, therefore, these crops are also grown in the truck-gardening areas near most large cities.

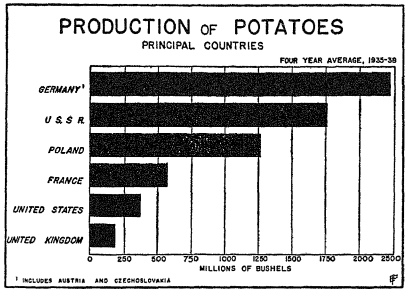


Figure 90.

Other Vegetables. Many of the other common vegetables are alike in thriving best in light sandy soil and in requiring a considerable amount of labor. They vary considerably in their capacity to stand shipment: beets, carrots, turnips, and other root crops are easily shipped, while tomatoes, melons, lettuce, and celery are likely to spoil if delayed en route. Certain railways make it a practice to give the right of way over passenger trains to fast freight trains laden with easily perishable vegetables.

Truck Gardening. The intensive cultivation of vegetables for the market is called *truck* or *market gardening*. Near almost every large city there is a farming area which specializes in providing that city with fresh vegetables. Usually, the area selected for this purpose contains loamy soil and is fairly level, whereas the hilly and clayey areas near the city are devoted largely to poultry and dairy farming.

One of the major truck-farming areas occupies the Sassafras soils on the inner margin of the coastal plain from Virginia to New Jersey. These gray-brown podzolic soils are sandy in texture, easily tilled, and respond to fertilization. The proximity of the Sassafras soils to the New York-Washington urban areas makes it worth while to cultivate them intensively. The rainfall is generally dependable but some of the farms have sprinkler systems to speed up the growth of vegetables and for use during short droughts. The soil warms up quickly in the spring, and proximity to the tempering Atlantic prevents great fluctuations in temperature. Thus the heavily fertilized sandy

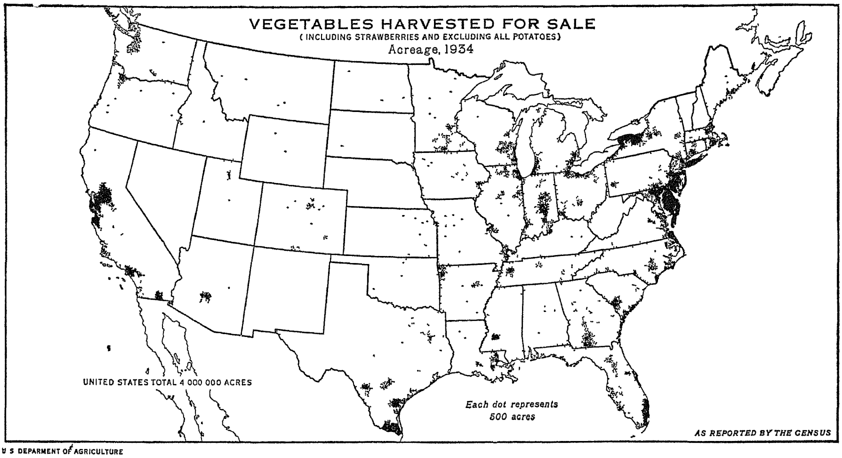


Figure 91. Compare with the population map (inside rear cover) The correlation would be even greater if vegetables raised in gardens for home consumption were included above. Note the presence of early vegetable and cannery areas which are away from the centers of population (Courtesy of U. S. D. A.)

loams, cultivated intensively by labor obtained in part from near-by cities and favored by an equable climate, can in a relatively short time produce a crop which trucks may carry in a few hours to near-by urban markets.

Early Vegetables. Before the development of high-speed transportation and refrigeration, the dweller outside of the tropics found that his winter diet was limited to those foods which would keep through the winter. Today, by paying a slightly higher price, the consumer may enjoy fresh vegetables throughout the year. Some of these are raised in hothouses near the large cities, but by far the greater portion is speeded north from the warmer southlands. In midwinter these vegetables are shipped from Florida, Cuba, and California to supply northern parts of the United States. Since it is desirable to minimize the distance to the market, the place of supply for early vegetables moves northward with the season. As a result of this climatic differential, a considerable, ever-shifting, high-speed, south-to-north trade is carried on during the cooler months in the United States. A similar trade exists in Europe, where shipments of early vegetables are received from northern Africa and certain oceanic islands and, later, from Italy, southern France, and Spain until midsummer, when vegetables can be produced adjacent to the great cities of northwestern Europe. Similar seasonal trade in vegetables has scarcely developed in Asia, Africa, or South America because their peoples still live in a relatively self-sufficient economy or because they cannot afford the higher prices charged for early vegetables.

Canning. The truck farmers near the metropolitan areas often have a larger harvest than the local market can absorb at the time. To take care of this surplus, canning factories have been established near by which buy up the surplus at low prices. These factories usually operate only during the summer. Baltimore is especially noted for its canning industry. The oyster-canning industry on near-by Chesapeake Bay employs, during the winter, many of the same workers who operate the vegetable-canning factories in summer.

Canning has greatly extended the area within which man can live on a well-balanced diet. A century ago sailors, explorers, campers, lumbermen, and prospectors were obliged to live on salt pork, bacon, beans, hardtack, and similar articles and often suffered from scurvy as a result. Today, such men can have almost as varied a diet as the dweller in an agricultural region because of that simple but revolutionary invention—the hermetically sealed, tin-plated can

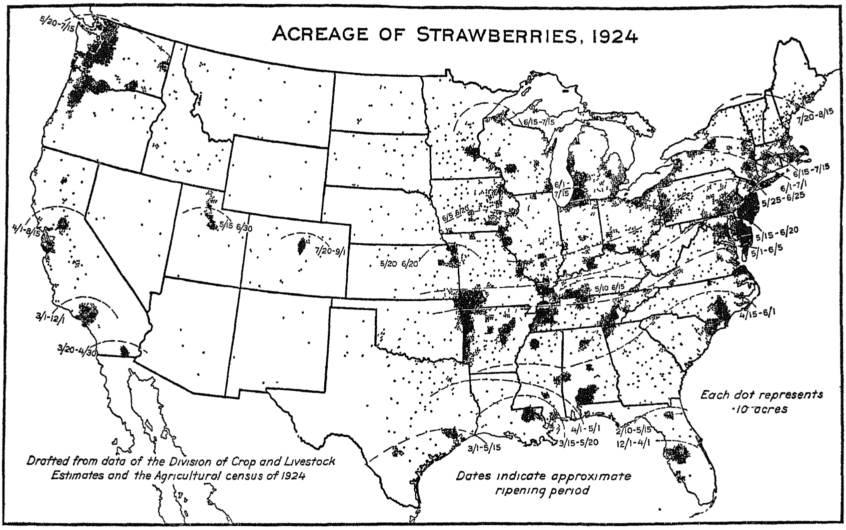


Figure 92. Fresh strawberries can be obtained from some place in the United States throughout the year. Similar maps could be constructed for many fruits and vegetables which enter into the "early vegetable" trade The price of these locally out-of-season crops increases with scarcity and distance to source of supply Find on this map the nearest place your fruit dealer could get fresh strawberries each month of the year Recent competitors of "early fruits and vegetables" are frozen foods which are often cheaper and easier to prepare than goods from distant farms (Courtesy of U S D A)

There is still a large production of fruits and vegetables near the market because, during its season. the local district can usually deliver its product to near-by metropolitan areas more cheaply than its distant competitor. The development of rapid transport, canning, freezing, and other means of preserving have, however, caused an increasing specialization in the production of such crops in regions with optimum conditions.

QUESTIONS FOR DISCUSSION

1. Are canned goods cheaper than the same quantity of fresh vegetables? Does the price of each fluctuate seasonally?
2. Would canning be more, or less, important if we did not have an exchange economy?
3. Do you think statistics of "vegetables grown for sale" include most of the vegetables produced? Why?

Fruits

Many of the fruits, like the vegetables, tend to be raised near the market, since they are equally perishable. However, as a whole, fruits tend to be more exacting than vegetables in their requirements. It is probably for this reason that the shift of production centers from near the market to regions with the optimum conditions has been more rapid in fruits than in vegetables.

Most fruits require considerable moisture, freedom from frosts during a relatively long growing season, and plenty of sunshine to insure proper ripening and good flavor. The water supply may be provided by irrigation or by rainfall. Since the roots of fruit trees penetrate a long distance into the ground, they are not affected by an occasional short drought, but the soil must be sufficiently deep and permeable to encourage soil drainage and the growth of a well-developed root system.

The need of a long growing season limits the poleward extension of fruit growing. Because of the sensitivity of fruits to frosts, the extreme minimum temperature during the growing season is much more important than the average temperature.

There are, however, certain special conditions

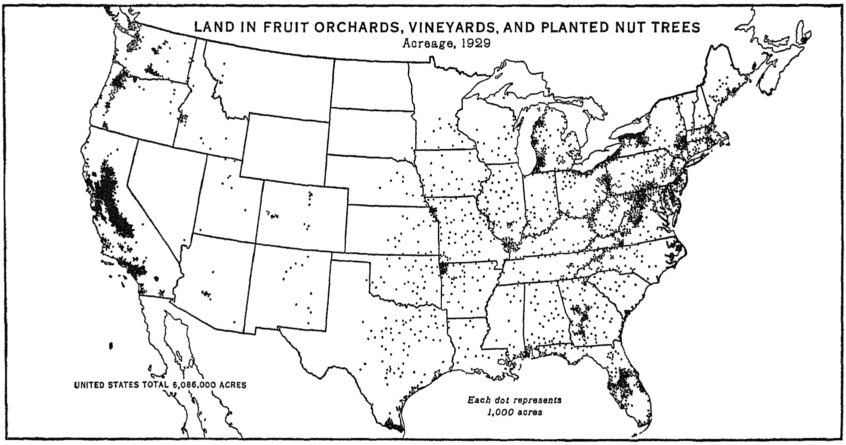


Figure 93 In the United States orchards are distributed almost as widely as farms, but the specialized areas are closely adjusted to temperature conditions Which fruits are found in each specialized area? Find an example of the influence of relief, of water bodies, of latitude. Further information on the distribution of vineyards is on p. 209, Figure 155 (Courtesy of U. S. D. A)

which allow fruits to be grown in surprisingly high latitudes. In general, fruits grow on trees or bushes, and such plants flourish almost as well on the rugged lands as on the plains. Consequently, orchards often occupy lands with too great a slope for easy tillage. A hillside location also has certain climatic advantages for fruit trees. The sunny side of any hill receives more units of heat per acre from the sun than an acre of level land in the same latitude. Another advantage is air drainage (see page 47) which explains why the trees located on the hillside are less likely to suffer from a light frost than those in the valley. In addition, orchards to the leeward of bodies of water are in an especially favored position. The water remains cool in the spring and prevents the orchards from blossoming until all danger of late frost is over. In the autumn, the warmth of the water prevents frost until quite late in the season. This has had an influence on the location of important fruit districts on the eastern shores of Lake Michigan, in the Ontario Peninsula, in the Annapolis Valley in Nova Scotia, and in many other areas at remarkably high latitudes.

The Apple. This is perhaps the most typical fruit of the cool parts of the temperate zone. The apple tree is hardy and will survive under a wide variety of climatic and soil conditions, but it does not give good results in the warm, moist climate of the Cotton Belt or in the cool wheat lands of Canada. The best apples in appearance, and possibly the most salable, are those produced under irrigation where sunshine is plentiful and water supply can be controlled. However, apples are commonly found on most American farms and along many roadways in northwestern Europe. The areas of large-scale production are, however, restricted mostly to hilly regions and areas adjacent to water bodies. The yield of a good apple orchard is surprisingly high (100 to 800 bushels per acre) and, consequently, apples are, like potatoes, a cheap food. The demand for apples in the industrial sections of Europe far exceeds the local production. Formerly, this demand resulted in a considerable international trade in dried apples but, since the perfection of refrigeration, Europe has been able to import the fresh fruit. The bulk of this import comes from the United States and Canada, but a small and increasing supply is being obtained from southern Australia and South Africa.

The Peach. This fruit is considered much more of a luxury than the apple because its perishable nature makes it much more difficult to market. It will grow almost as far north as the apple, but is somewhat more sensitive to frost. In the United States, during the early part of the summer, the Georgia peach is

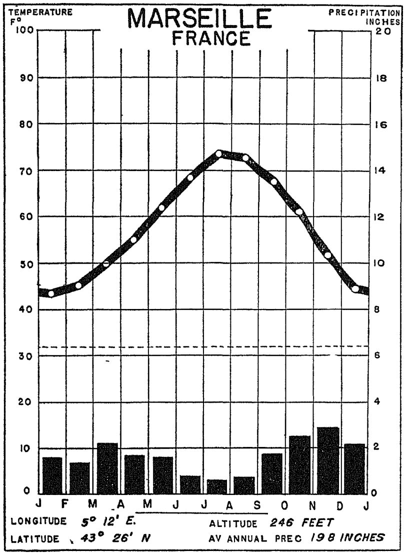


Figure 94 This mild climate, characteristic of the Riviera of southern France, is ideal for fruits, flowers, and early vegetables.

rushed north in cooled freight cars; during the late summer, peaches are obtained from orchards north of the Mason and Dixon Line. In the winter, peaches are obtainable only from cans, unless the buyer pays an exorbitant price for fresh peaches imported from Argentina and Chile.

The Grape. Grapevines were present in both the Eastern and the Western hemispheres before Columbus crossed the Atlantic. The European varieties (Tokay, Malaga, etc) will grow only in those parts of the United States having a climate similar to that of southern Europe. The American varieties (Concord, Delaware, etc) are grown in the more continental climates found in the eastern United States. They will grow about as far north as corn. Grapes are important in world commerce. They are shipped fresh in cold storage, but the trade in grape juice, wines, and raisins (dried grapes) is much more important.

The wine industry is an interesting example of the importance of small environmental differences. The grape juice obtained from each vineyard differs in flavor (often very slightly) from that from any other vineyard. Much of this is due to different varieties of grapes, but an important part is due to local variations in soil and climate. These local variations may even differ from year to year because of fluctuations in the weather and in the soil condition. Hence, the wines of certain years (that is certain *vintages*) are considered superior to others. Even if the grape juice is identical, the ferments used may differ. Thus wines made from the same types of grapes by the same process vary, sometimes minutely, sometimes greatly, from country to country, from vineyard to vineyard, and even from year to year. Such minute differences in a luxury commodity greatly increase its interregional trade.

Citrus Fruits. The fruits described above are injured by frost, but in the case of the citrus fruits (oranges, lemons, limes, grapefruit) the trees as well are injured, and often killed, by frost. Consequently, they are grown only in regions that are free of heavy frost throughout the year. The warmer half of the Mediterranean climate seems to be best suited for these fruits, although they can also be grown in the tropics and parts of the subtropics, such as Florida and southern China.

Citrus fruits possess a tough, thick skin and, consequently, are not easily bruised or spoiled in shipping. For this reason, international trade in these fruits developed as early as a century ago when lemons were shipped to the United States from Italy by sailing vessel. Today there is an important export of these fruits from all regions of Mediterranean climate to the cooler regions: from California to all parts of the United States; from Italy, North Africa, Palestine, and Spain to northwestern Europe; from Chile to Argentina, and from Australia and South Africa to England. The warmer parts of the humid subtropical climate, such as Florida and southern China, are also important for oranges and grapefruit.

Limes are an important citrus fruit obtained largely from the Antilles and around the Mediterranean Sea. Lime juice was a very important part of the diet when fresh foods were not available during the winter, and was especially important on shipboard.[1] Its popularity was due to its power to prevent scurvy and other diseases. It is now known that this power was the result of an unusually high vitamin content. Lime juice is still an important commodity, but an increasing portion of the crop is exported fresh or used in the manufacture of citric acid.

[1] The regular use of lime juice was required on British vessels, hence British sailors are often called "limeys."

California and Canning. The valleys and hillsides of central and southern California have almost ideal conditions for the intensive raising of fruits and vegetables. There are fertile soils, abundant sunshine, an almost total absence of frost, and a great variety of temperature ranges due to differences of altitude and latitude. Most temperate and subtropical crops not only can grow somewhere in California but grow under physical conditions close to the optimum. Rainfall is sparse in most of the valleys, but the snow-covered Sierra Nevada feeds streams which suffice for extensive irrigation. In fact, even the lack of rainfall may be counted as an advantage, for fruits raised by a steady water supply obtained from irrigation ditches are better shaped than those whose moisture is obtained from the less regular rainfall.

This California "Garden of Eden," was, however, valueless, except locally, until its fruits and vegetables could be transported to a market which was two to three thousand miles away. The first California fruit to appear in the Eastern market was the dried prune. The dry summers of California's Mediterranean climate were ideal for drying fruits in the sun and, soon, dried grapes, peaches, figs, currants, and apricots found their way eastward.

However, it was another invention—canning—that put California fruits and vegetables in every grocery store in America As late as 1872, the hermetically sealed can was still generally unknown, and until the beginning of the present century the prejudice against canned foods was widespread Today all that is changed, and extensive advertising programs tell the nation about the excellence of California canned goods.

California fruit and vegetables are unusually uniform in size because of the dependable climate and the dependable water supply. This uniformity is very important in canning—especially in modern canning which is done largely by machinery. If the machinery has been adjusted to put six peach halves in each can, it upsets the system if some of the peaches are larger than others. The California peach is very uniform in size and shape, and the housewife who opens a can of them knows, in advance, exactly how much fruit she will have.

Tropical Fruits. Dates, oranges, lemons, grapefruit, figs, pomegranates, avocados, tamarinds, and persimmons are well-known tropical fruits which are, however, usually produced commercially in the northern *sub*tropical regions. Many crops are produced in large quantities near their poleward limits, since this practice seems to result in better quality. Better soils and soil management, better labor, fewer pests and plant diseases, account in part for the improvement. The advantage of nearness to market is also important in pushing tropical fruits nearer their northern limits.

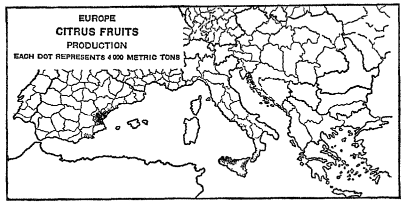


Figure 95 Note the concentration of production in a few valleys and adjacent hillsides along the coast Why is the Atlantic half of the Iberian Peninsula unsatisfactory for a large production? (From *Geography of the World's Agriculture*)

Bananas. Bananas thrive best on alluvial soils in the tropical rainforest. Elsewhere in the tropics, they may be raised by the use of irrigation during the dry season or by fertilization in regions of mediocre soils. Almost every tropical hut has a banana tree growing near it. The fruit is consumed fresh as in the middle latitudes, but it is also dried and made into flour, fed to animals, or fermented and distilled to make alcohol. Certain varieties (usually known as *plantains*) are used for cooking and may be prepared by boiling, baking, or frying.

Only two of the many varieties of bananas are imported into the United States and Europe. However, this trade was unimportant until after 1860. The development of the banana trade was delayed by the need for keeping the bananas at just the right temperature while in transit. But several large companies established plantations, and connected them with the markets by means of refrigerated steamers and refrigerated freight cars. As the result of the enterprise of these companies, the banana is now one of the most commonly used fruits in the United States. The principal commercial producing areas are in Central America, the West Indies, and Hawaii for the North American market; in the Canary Islands and the West Indies for the European market; and in Brazil for the Argentine market. The quantities produced on the plantations for export are, however, probably insignificant compared with the number raised on scattered trees for home consumption.

Pineapples. These are widespread in the tropics wherever there is suitable soil and a rainfall of forty

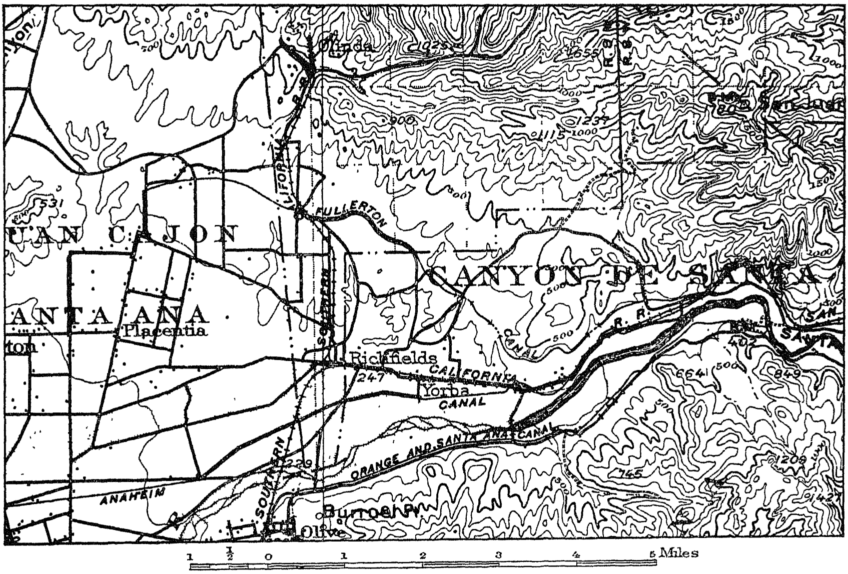


Figure 96. A contour map of a fruit-growing area on an alluvial fan at the mouth of a canyon Note the irrigation canals. (From Anaheim, California, sheet, U. S Geological Survey)

inches or more. Careful cultivation and good soil are necessary to produce a well-flavored fruit and, therefore, the commercial crop is produced on large, well-managed plantations. Pineapples first entered the market in important quantities in canned form Until the perfection of refrigeration it was difficult to market fresh pineapples, since they spoil quickly. They cannot be picked half ripe like bananas, for unripe pineapples are very sour. Hawaii is the outstanding pineapple producer, but Puerto Rico, southern Florida, Jamaica, Formosa, and Malaya are becoming important competitors.

Other Tropical Fruits. There are many other tropical fruits which might be marketed in the middle latitudes. One of the most promising is the mango which, next to the banana, is the most common of tropical fruits. Its flavor, texture, and size vary greatly from place to place and from variety to variety It is extremely perishable. Mangoes have been placed on the market in New York and, although they were good in quality, the sale was limited by the high price.

Other tropical fruits of considerable importance are the guava, sapodilla, mangosteen, durian, custard apple, litchi, passion fruit, loquat, papaya (pawpaw), and jujube This list by no means exhausts the fruit-producing possibilities of the tropics. In almost every decade, some tropical fruit or important variety is discovered by tropical planters, but a long period may pass before many of these enter into world markets.

Many tropical agricultural products could be used more widely in the temperate zone. However, the introduction of a new product is far from a simple task. A demand must be created, marketing arrangements perfected, refrigerated transportation provided in many cases, and a steady supply of a satisfactory quality assured. Millions of dollars must be invested in such an enterprise and success would be far from certain.

QUESTIONS FOR DISCUSSION

1. Why does the raising of fruit tend to be more restricted, geographically, than the raising of vegetables?
2. Why is the international trade in fruit more important than that in vegetables?
3. What technical developments have contributed to the increase in the fruit and vegetable industries of California?

CHAPTER 18

WHEAT, RICE, AND THE MINOR CEREALS

WHEAT and rice provide an interesting contrast. These two cereals supply most of the breadstuffs of the world—but wheat is raised under conditions almost completely opposed to those of rice. Wheat is the staff of life of European civilization, while rice holds the same position among the poverty-stricken millions of southeastern Asia. Wheat is grown largely in a cool, rather dry, climate; rice grows in a tropical, or subtropical, rainy climate. Wheat is often grown extensively by using large amounts of machinery; rice is usually grown very intensively with cheap hand labor. Wheat is a leading commodity in world trade; rice is used largely at home in a relatively self-sufficient economy.

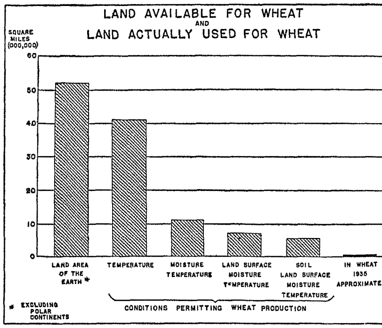


Figure 97. (After O E. Baker in *Economic Geography,* March, 1925)

Wheat

Why is wheat the most widely grown of all cereals? As in most geographic problems, the answer must consider not only the physical environment but also many historical, economic, and biological factors.

Wheat has been cultivated for at least 6000 years. The date and place of its first cultivation are unknown but it seems certain that the location was near the eastern end of the Mediterranean Sea. Many of the peculiarities of the plant represent adaptations to the Mediterranean climate.

The demand for wheat is easily explained. Its use is sanctioned by custom. Furthermore its product provides a well-balanced and palatable food. Wheat bread usually is finer and tastes better than that from any other grain. This is, in part, due to the high gluten content which allows the wheat flour to release slowly the gasses formed in mixing and baking and thus lightens the bread.

The Land of the World Suited to Wheat. In a study made in 1925, Dr. Baker of the United States Department of Agriculture analyzed the land of the world from the standpoint of its suitability for wheat production. His conclusions are summed up in Fig. 97, which shows that about one-tenth of the world is within the limits of wheat production. The following analysis outlines the physical factors which prohibit the growth of wheat on nine-tenths of the land

Temperature. Wheat may be classed as a hardy crop. It can be grown under colder conditions than most crops and no arable land is too hot for wheat, if it is not too humid. The poleward limit for wheat is, approximately, an average temperature of 57° F. during the three warmest months. Only barley, oats, potatoes, and some hay crops may be grown under colder conditions than these. Wheat has been grown from 66° N. to 45° S. Only the polar regions and elevated areas such as the Andean and Tibetan plateaus are too cold for wheat.

Moisture. Like most crops, wheat has both arid and humid limits. In the cooler regions, the arid limit is about ten inches of precipitation, while the humid limit is approximately forty inches. In the warmer regions, such as northern India, the limits are twenty and seventy inches. These limits are necessarily approximate since the *exact* limits vary with the seasonal distribution of the precipitation, the rate of evaporation, and the nature of the soil.

Barley is the only important grain that may be grown with less rainfall. Corn, rice, and oats can sur-

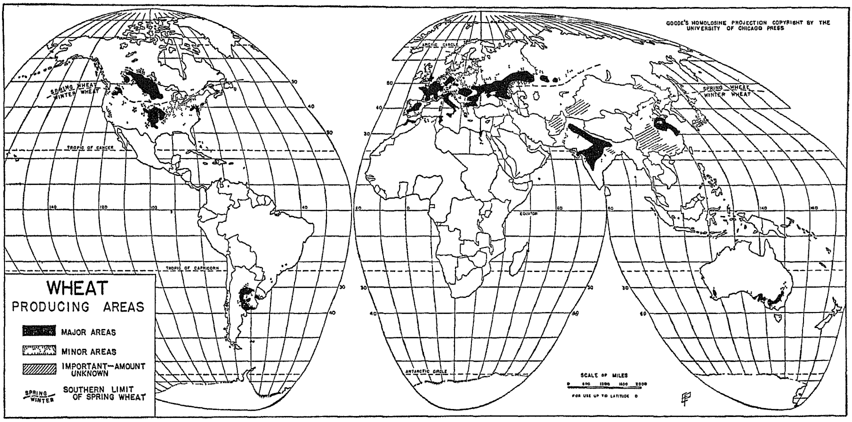


Figure 98. The major wheat areas are with a few exceptions in semi-arid regions.

vive with greater rainfall than wheat. About one-third of the land area of the world (excluding the polar continent) is too dry for wheat and about one-fourth is too wet.

Topography. Rough topography is unfavorable to the production of most field crops and especially to the production of wheat which is so largely handled by machinery. The steepness of slope which will be utilized for the growing of this, or any other, crop in a given area does not depend wholly on physical considerations, however. In a densely crowded area, relatively steep land may be used because it is absolutely necessary to do so. In parts of the Orient, wheat is even grown on the very narrow terraces which have been built on steep hillsides to supplement the small areas of flat lands.

Soil. Wheat requires relatively good soil. The loams are best under practically all conditions. In the warmer areas, clay is usable and, under cooler conditions, a sandy soil is not an overwhelming handicap. Gravel and peat soils are unsuited to it. The best wheat soils are the chernozems and the chestnut soils on the drier margins of the chernozems.

Wheat Breeding and the Distribution of Wheat. The present wide limits of wheat, as well as of many other common economic plants, are due partly to the work of farmers and agricultural scientists in producing varieties especially adapted to extreme conditions. Even before the scientific study of wheat-breeding began, there were seven recognized species (as classified by Linnaeus) including the common or bread wheats, the soft club wheats (used for pastry), and the hard durum wheats (used for macaroni). Many of these wheat species have also been developed into *winter wheats* and *spring wheats,* two types which have similar temperature and rainfall requirements but whose requirements are met at different seasons of the year.

Winter Wheat. The oldest type of wheat, winter wheat, is planted in the autumn and harvested in early summer. In the cooler parts of the earth, it grows very slowly during the winter, and resumes its growth at a rapid rate with the coming of warmer weather. The winter must be damp with relatively little frost, or, if the winter is cold, there should be a snow cover to protect the roots from freezing. The spring should be cool and wet; and the early summer, rather dry and sunny. Most of the eastern part of the United States has rather severe winters and summers too wet to be entirely satisfactory for winter wheat. Western Europe with its marine west-coast type of climate, having cool wet winters and drier summers, is ideal. This is, undoubtedly, one of the reasons why yields per acre in winter wheat are consistently higher in western Europe than in the United States (from 30 to 40 bushels per acre in western Europe as against 10 to 20 bushels in the central and eastern United States). In the Mediterranean climates, the principal type is winter wheat. The winter maximum of rain-

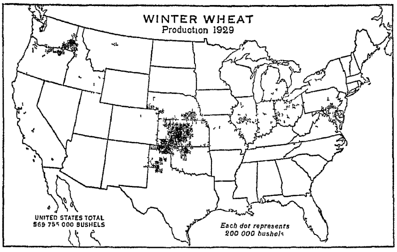


Figure 99 The small place that wheat plays on eastern farms is largely due to the competition of more profitable crops. (Courtesy of U S. D A)

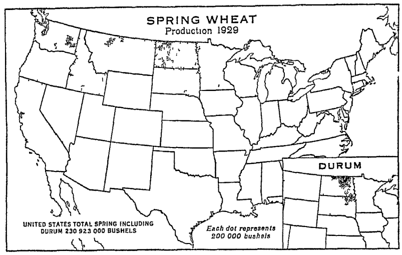


Figure 100 Note the gap between the southern boundary of spring wheat and the northern boundary of important winter wheat production (Figure 99) How might it be explained? Durum is a drought-resistant variety of spring wheat which was introduced into the United States from Russia about the beginning of the century. (Courtesy of U. S. D. A)

fall is ideal, but in most such regions the winters are not cool enough to give the best results

Soft winter wheats are the principal type grown in eastern United States Most of them are related to the Mediterranean variety introduced from Italy in 1819 They were not well suited to the less humid parts of the United States, however, and so the first hard red winter wheat—Turkey wheat—was introduced by a small group of Mennonites who emigrated from southern Russia to Kansas in 1873. This was a major event in American wheat history. This drought-resistant variety now occupies one-quarter of the wheat acreage of the United States. Other important winter varieties developed from Russian wheats are the Blackhull and Kanred (Kansas red).

The great wheat areas of Argentina have soil and climatic conditions roughly similar to those of Kansas and Oklahoma. Barletta, an Italian variety, is most widely grown but is gradually being replaced by the Kanred, Blackhull, and locally developed varieties.

In northern India and China, there are important winter-wheat areas although most of the rainfall comes in the summer. The summers are too hot and wet for wheat production, but the cool winters with some cyclonic rainfall are satisfactory for wheat. Often the same field is used for vegetables or rice during the summer months.

Although the dense population would seem to necessitate the most efficient use of the land, wheat yields in India and China are rarely high. Labor is used intensively but the excessive rainfall during the usual harvest season and the use of a poor quality of seed, limit the yields. Indian experiment stations have made important contributions to wheat breeding (the Pusa and Punjab varieties), but it has been difficult to get the millions of illiterate Asiatic peasants to use the better-grade seeds.

Spring wheat is essentially the same plant as winter wheat. Although there are specialized winter varieties and spring varieties, many spring varieties can be planted in the winter and *vice-versa.* Spring wheat is grown primarily in areas having winters too severe for winter wheat. It should have adequate rainfall throughout the summer and a dry harvest season in the late summer and early autumn. These conditions are ideally met by the humid-continental climate with *short summers.*

Most spring wheat is hard wheat and is grown on chernozem and other steppe soils. The exploitation of these lands in the United States and Canada occurred largely within the last fifty years.

More striking than the growth of an oak from an acorn is the fact that the vast hard spring wheat industry in the United States with all the milling, baking, transportation, and trading dependent on it, developed from a few seeds saved from a single wheat plant The origin of this plant shows how plant breeding cuts across and disregards national boundaries, to develop products useful to all men and all nations.

The variety that founded the hard spring wheat industry came originally from Galicia in Poland From Galicia it went to Germany. From Germany it went to Scotland From Scotland it went to Canada. From Canada it came to the United States.

It was David Fife of Otonabee, Ontario, Canada, who first obtained a small sample of the wheat from a friend in Glasgow, Scotland. He sowed it in the spring, but it proved to be a winter wheat. A single plant of spring wheat developed out of the lot, however, and this was saved and increased. From this descended the wheat that became known throughout Canada as Red Fife. The cultivation of Red Fife wheat in the United States dates from 1860, when J. W. Clark, a Wisconsin farmer, had an excellent crop.

The really efficient use of hard red spring wheat, however, had to await the invention of the roller mill and the purifier which could handle the grain effectively

This Red Fife, in turn, became one of the parents of the world-famous Marquis wheat, also developed in Canada by C E. Saunders Marquis was a cross between Red Fife and Hard Red Calcutta, and it was introduced into the United States in 1912 by commercial seed and grain firms.[1]

The Economic Factors. Figure 97 also shows that only one-tenth of the land within the limits of wheat production is actually used for wheat production. The other nine-tenths is not devoted to wheat for one or more of the following reasons:

(1) some other crop is more profitable than wheat;

(2) the land is beyond the extensive margin of cultivation;

(3) wheat does not fit into the prevalent system of farming.

Competing Crops. In general, the rule holds that "the crop which is most limited by its physical requirements for production will, if the demand is sufficient, have first choice of the land." Thus, corn, cotton, and many vegetables and fruits, all of which have climatic limits narrower than those of wheat, use land in all parts of the world which, from a physical standpoint, might be used for wheat. A region which can raise both cotton and wheat will usually concentrate on cotton because there is less land on which that crop can be grown, and the price of that crop is, therefore, higher. This helps to account for the tendency for wheat to be grown near its arid limits. In the Argentine, Chile, Australia, India, Russia, Siberia, Italy, and western United States, wheat is grown on the drier lands, because other crops which need more rainfall must have the moister lands; and, because the area in which they can grow is limited, they yield a higher price and are more profitable users of the better land.

Economic Margins and Wheat Prices. The location of the economic margins varies with the price of wheat. If the consumers of the world require four billion bushels of wheat annually, they must pay a high enough price to make it profitable to cultivate sufficient land to produce that amount. The price will be determined not by the average cost of wheat production, but by the cost to the farmer who uses the poorest quality of land required to produce all the wheat demanded. Should the demand for wheat increase, the price will ordinarily increase because less efficient units of land, labor, and capital must be attracted into wheat production.

[1] *Yearbook of Agriculture, 1936,* pp 214-15. This *Yearbook* and the 1937 number contain excellent summaries of most of the plant-breeding experiments on various crops.

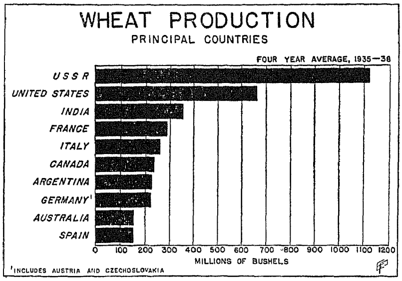


Figure 101.

There are four important ways [2] by which the supply of wheat may be increased:

1. Former submarginal land may be used for wheat (movement of the extensive margin toward the limits),
2. Lands within the margin may be used more intensively (movement of the intensive margin);
3. Lands formerly used for other crops may be planted in wheat,
4. The use of new techniques may be hastened by an increased demand. Such technical changes cause increases in production which may be maintained through later periods of lower demand.

The world price for wheat is generally determined by supply and demand as indicated at the great grain exchanges. Chicago is the major American wheat market but its prices are often determined by conditions prevailing in Liverpool. This English port is in the midst of the greatest wheat deficit area in the world. Wheat surpluses from Canada, the United States, Argentina, Australia, and Russia are shipped to Liverpool. Wheat exchanges are found in other countries, but the local price is usually closely related to the Liverpool price. Wheat-surplus regions have prices lower than the Liverpool price, usually by the cost of shipping to Liverpool.[3] The price in deficit regions

[2] This analysis of margins and price is far from complete For more detailed analyses of these economic problems, the standard works on economic theory should be consulted.

[3] Average Price·

No. 2 hard winter wheat during July, 1930

Liverpool	$1.01
Chicago	.88½
Difference	.12½

or approximately the cost of shipping from Chicago to Liverpool Prices in deficit countries in Europe are harder to explain because of high protective tariffs

Comparable prices (July, 1930) after tariffs have been paid:

Berlin	$1.85
Paris	1.64

Contrast these prices with that of 97 cents at Budapest, capital of a wheat-surplus country.

is usually determined by the cost of getting the wheat from Liverpool or from the surplus region (including tariff). Prices of most agricultural products vary according to the season, but there is little seasonal element in wheat prices. The two major varieties of wheat and the widespread growth of wheat produce a wheat harvest somewhere during every month of the year. Thus the winter wheat of Argentina enters the Liverpool market six months later than the winter wheat of England, and the spring wheat of Russia is harvested between these two winter-wheat harvests.

The above accounts may make it appear that the amount and intensity of cultivation respond exactly to price changes. Such a precise relationship is impossible because no farmer can predict next season's weather, the size of the crop, or the cost of production per bushel. Nor can the farmer foresee those changes in tariffs, subsidies, techniques, and weather in other wheat-growing areas which may affect the production and consequently the world price. Even if a farmer could predict these many unstable factors, he could not instantly adjust his agricultural system to the new situation because his past purchases of machinery, his scheme of crop rotation, and his specialized knowledge may urge the continuance of his present crops and methods. All the farmer can do is to estimate the probable future market and, within the limits set by his land, equipment, and knowledge, make gradual adjustments to fit the economic situation.

Farmers throughout the world are watching markets and making such adjustments. If the wheat farmers of the world overestimate the amount of wheat they should produce, or if, because of favorable seasons, they produce more than expected, the price may fall below production costs of many of them. On the other hand, if their crop yields less than the demand, prices will rise. Higher prices may attract more farmers, more land, and more capital into wheat cultivation the following season. The resulting increased crop may cause a fall in price and a loss to many producers. Thus the farmer, especially if he sells to distant markets, constantly gambles on the future price as well as on the future weather.

Wheat and Agricultural Systems. If wheat growing is to be profitable, it must fit in with the whole economy of the farm. It is hardly worth while to raise a few acres of wheat if that crop necessitates the purchase of much additional machinery. Again the farmer may be very busy with other activities when wheat should normally be planted and harvested. For these reasons, wheat is rarely cultivated on dairy, poultry, and truck farms, even when good wheat lands are available. However, wheat fits well into two agricultural systems: diversified general farming and one-crop extensive farming.

Diversified Farming. The large wheat production in western and northwestern Europe, in the Middle West and northeastern part of the United States, and in China—is of this type. Although land in these regions is relatively valuable, production may be carried on in competition with the cheap, one-crop lands for the following reasons:

1. The wheat is grown in better climatic conditions, therefore the yield per acre is higher.
2. These areas are nearer markets and transportation costs are lower.
3. On a mixed farm, wheat (especially winter wheat) often helps to distribute the seasonal demand for labor, animals, and machinery, because its planting and harvesting come at times when the demand by other crops is light.
4. Wheat fits into the general system of crop rotation prevailing in such a region.

This last factor is of considerable importance. The rotation often takes the following form: (1) A crop—such as corn, potatoes, or sugar beets—which requires tilling, thus keeping down the weeds and working the soil; (2) a grain crop—such as wheat, oats, rye or barley, and then (3) a hay crop, which puts nitrogen and humus back into the soil and the roots of which help to prevent erosion

Wheat in One-crop Farming. This system is relatively new, for it can exist only where transportation is available and where there is a considerable regional division of labor. Taking the world as a whole, this system has become important only since about 1860. At that time, railroads were beginning to penetrate the interiors of the continents and machinery was being developed which made this extensive type of wheat growing practicable.

The subhumid and semiarid regions with rich chernozem or chestnut soils are almost ideal for one-crop wheat farming. With the coming of the railroads, these areas were connected with distant markets. With the invention of agricultural machinery, great areas having this type of soil could be exploited, extensively, by a population which must remain sparse because the lack of water precludes any dense population. Other characteristics of wheat which make it an ideal crop for such regions are its high value in proportion to its bulk, which enables it to bear the cost of transportation to distant markets, and its relative imperishability.

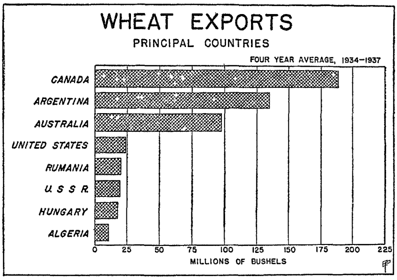


Figure 102. Every continent sends some of its surplus wheat to northwestern Europe

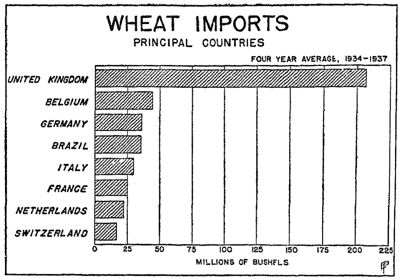


Figure 103. Why is the United Kingdom so outstanding as a wheat importer?

Wheat is a crop ideally adapted to pioneer conditions. In parts of the United States and Canada, in the Argentine, and in Australia it once occupied most of the land on the frontier. As population grew, however, and land came to be needed for other crops, wheat has been pushed farther toward its arid limits and the better land used for corn, or for general farming. One of the principal reasons for the importance of the one-crop system in wheat production is that wheat is often grown in conditions beyond either the limits or extensive margin of other crops.

World Trade in Wheat. Although more than forty countries produce more than a million bushels of wheat per year each, there are only eight which are important exporters. This is because much of the wheat is produced on mixed farms in regions of dense population and is consumed locally. This is especially true in Europe, which produces about half of the world total, on the average, but even its countries of greatest production are relatively unimportant as exporters. China is also probably one of the largest producers but consumes most of its product locally. Most of the principal exporters are countries which have large areas of arid lands and small populations in proportion to their areas.

The principal importers of wheat are the great industrial countries, notably the United Kingdom, Germany, Belgium, the Netherlands, and Japan. All of these have dense populations and depend on foreign trade for most of their food supply. It will be noted that France and Italy are important importers because, although they produce large quantities of wheat on mixed farms, they have large populations which use wheat as a staple article of diet. Brazil imports wheat because, while it is primarily an agricultural country, it specializes in tropical or semitropical crops such as coffee, cacao, and tobacco. A considerable part of its population has high living standards and demands wheat, but much of its area is too tropical to be really favorable for wheat production.

QUESTIONS FOR DISCUSSION

1. A greater proportion of spring wheat than of winter wheat is raised by machine methods. Why? Why does spring wheat represent such a small proportion of the world's total wheat production?
2. Why has "pioneering in techniques" been especially important in wheat production?
3. Is drought likely to cause a world wheat shortage? Is it likely to have serious consequences in individual wheat-raising countries? Which countries do you think are most likely to suffer from drought in their wheat-raising areas?

Rice

Physical Requirements. There are so many varieties of rice, each with slightly different requirements, that it is difficult to set absolute limits for rice production. In general, it requires high temperatures and abundant water supply, either from rainfall or irrigation. As can be seen from a comparison of the map of world rice-producing areas (Fig. 104) and the map of mean annual rainfall of the world (inside rear cover) the principal rice area in monsoon Asia lies almost entirely within lands having more than forty inches of rainfall. In both North China and western India, where the rainfall is less than that amount, wheat, barley, or millet becomes the principal cereal. The temperature during the growing season needs to be very high. Where the hot and wet season is long, more than one crop may be grown and, in some favored regions in India and China, three crops may be produced in a year.

The plant which is thought to have been the an-

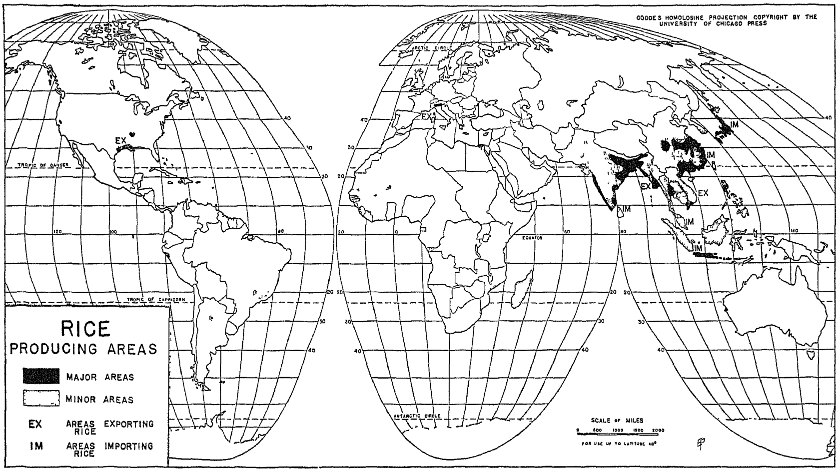


Figure 104. The high rainfall requirements of rice almost exclude it from the wheat-growing areas.

cestor of modern rice developed in swampy ground somewhere in southeastern Asia. Most of the rice grown in Asia today is produced under conditions closely resembling those in the original habitat. A layer of water several inches deep covers the field during the period of greatest growth. These swampy rice fields are called *paddies* and the rice produced on them before it is husked is *paddy rice*.

More than three-quarters of the world's rice is produced under the paddy system. Some rice is sown broadcast on moderately moist lands and is raised and harvested like wheat or oats. Because these fields are usually on hillsides, this rice is called *upland rice*. It is raised mostly for local consumption and rarely enters into world trade.

The topographic requirements of paddy rice are very definite. The land must be almost level, having just slope enough to keep the water barely moving through the field. The great flat river plains and deltas of eastern Asia are therefore the regions of greatest production. Where flat land is not sufficient, its characteristics are often reproduced artificially by building terraces along the hillsides. This is especially common in Japan, Java, South China, and the Philippine Islands which are mountainous regions having good rice climates.

The production of rice in paddies also requires a very specific combination of soil conditions. The top soil should be fine and easily worked—the silt laid down by the overflow of rivers is ideal. The subsoil should be very compact a few inches below the surface to allow the water to stand in the field and not drain off too rapidly underground.

In some areas, the rains are steady enough during the growing season to furnish all the water necessary. Elsewhere, water must be put on the fields by diversion from streams, from irrigation ditches, or by being pumped onto the fields from wells or bodies of water. The ideal condition is a source of water above the fields to be flooded, but this is often unobtainable. One of the compensations for the difficulties of production by terraced paddies is that water flowing slowly from one level is used on the next lower one. This effects not only an economy of water, but allows the silt carried off one level by the water to be deposited on the next.

Rice Growing under the Paddy System. The growing of rice in paddies in central China is typical of conditions under this system throughout southeastern Asia. At the beginning of the crop year, the farmer devotes considerable time to repairing the dikes, drainage ditches, and canals and to leveling off the fields. About April 15 (earlier in southern China) the rice seeds are sown in a seedbed of soil, highly

fertilized with ashes. The seeds are scattered so thickly as to almost cover the surface. They are then beaten gently into the soil. Often in the evening the bed is covered with a thin layer of muddy water which is drained off again the next morning so that the sun's warmth and fresh air may penetrate the soil.

About a month later the rice seedlings are transplanted by hand into larger fields These fields have previously been used to grow some fast-growing crop such as winter wheat Thus, by this transplanting process, the Chinese get two crops from the same field The larger field has already been plowed, fertilized, weeded, and then stirred up so as to free the soil from any lumps which might prevent the rice roots from penetrating it. The rice is then transplanted into rows about a foot apart, and the field is flooded.

The care of the rice does not cease with the transplanting. At frequent intervals the field is hoed so as to stir up the mud and provide aeration Fresh muddy water is often pumped onto the fields and brings with it air and dissolved plant foods. Although the water in the paddies appears stagnant, part of the technique is to keep the water always slowly, but surely, in motion.

Muddy water is not the only fertilizer used in China. Rice straw, animal and human manure, ashes, and garbage are commonly applied to the fields. Human manure, rarely used in the Occident, is one of the main nutrients in Oriental agriculture. Every morning the night soil in the cities of China and Japan is collected and sold to the farmers.

Before the harvest season, the rice fields are drained and allowed to dry out. This encourages the ripening of the grain. In some sections of China, other crops are planted between the rows of ripening rice, and thus a third crop is produced on one field in one growing season.

Intensive Cultivation and Low Standards of Living. There is an almost continuous demand on the labor of the farmer, since he has so little land that he cannot let it rest a moment when it can possibly be bearing crops. In large areas in China, one and one-half to five acres suffice to support a large family, supplying almost all of the food, directly, and yielding small surpluses for taxes, clothing, and other necessities. Statisticians have calculated that approximately twenty-four hundred pounds of rice are required to feed the average Chinese peasant family. To raise this rice would require about one and one-half acres of *good* farm land in *good* years. However, probably more than half of the Chinese rice farmers

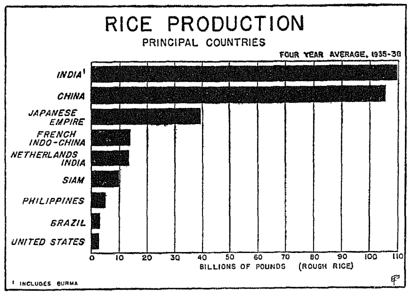


Figure 105.

have farms of smaller size than this; that is, more than half of the Chinese rice growers are inadequately fed in average years.

Everywhere in the Asiatic rice areas labor is the surplus element, while land and capital are the scarce ones. However, strange as it may seem in lands where man is willing to work so hard for a bare subsistence, in most of these countries there is still much unused land capable of producing food and raw materials but not under the paddy system. To utilize this land, extensive machine agriculture connected with world markets by efficient transportation would be necessary.

Java. The rice situation in Java represents an interesting attempt to combine self-sufficiency with the production of a cash crop for export. Java grows large amounts of sugar for export, but the Dutch Government has been wise enough to limit the sugar industry's use of the soil and, thus, has insured the permanency of the soil resource. The Dutch law requires that rice must be grown on every suitable field at least every other year to provide food. Since the rice is grown by methods such as described for China, the fields are constantly being refertilized.

Occidental Rice Production. Italy has, in the Po Valley, a region of very hot summer temperatures and abundant irrigation water. Much of this valley has been planted in rice to give a high yield in a country with a crowded population. In the United States, rice is produced under a system radically different in many ways from that in the Orient. The large producing districts are in the Mississippi bottom lands in Arkansas, in the low-lying Gulf Coastal Plain land of Louisiana and Texas, and in the delta of the Sacramento River in California. In most of these areas, a modified paddy system is used. The dikes between

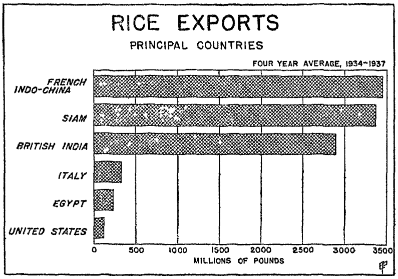


Figure 106 Burma, now a separate British colony, provides most of the rice export here attributed to India. Siam is now officially known as Thailand.

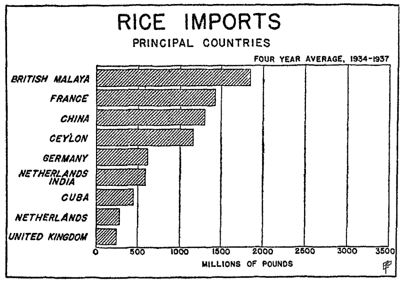


Figure 107. The consumption by plantation laborers accounts for a large part of the rice imports The per capita consumption of rice in occidental countries is small.

the "paddies" are rounded off so that the machinery which is used for almost every operation may pass easily from one field to another Land is used *extensively* in a country such as the United States where labor is expensive and capital is plentiful. Water is usually furnished by power-driven pumps or windmills In the California area, the land used is usually heavily alkaline and is unsuited to most crops which must be grown on relatively dry fields. The continuous, slow passage of the irrigation water over it, however, tends to wash out this alkali and improve the land. The rice produced is of the Japanese type and finds its largest market in Japan, Hawaii, and Puerto Rico.

Rice Production and World Trade. Every country in monsoon Asia is an important rice producer; China, probably the leading producer, is also a rice importer. This is because the population of China is so dense that food must be purchased with the proceeds of such exports as silk, tea, and cotton. So important is rice to China that its export is prohibited by law, lest a high world price drain China of its food reserves. Japan and Java, two major producers, are also rice importers. India produces huge quantities of rice but has only a small export.

The major rice exporters—French Indo-China, Thailand (Siam), and Burma—produce their crops on rich alluvial soils Although the population density of these rice-growing areas is high, it is much lower than in the other rice-producing areas of Monsoon Asia. Thus the local demand is relatively small and there is a surplus for export. Only a very small part of the world's rice production enters into international trade because most rice is consumed near the farm on which it is raised.

QUESTIONS FOR DISCUSSION

1. Much of the land in the lower Mississippi Valley has optimum conditions for rice production Why is it rarely used for this purpose?
2. Why does even a slight deficiency of rainfall produce a famine in parts of India and China?
3. How does rice cultivation—as practiced in central China —insure that each of the needs of a productive soil shall be provided?

Minor Cereals

Corn, wheat, and rice—the major cereals—occupy about one-third of all the land used for crops and more than one-half of all the land used for cereals. Since the major cereals usually have a high yield per acre compared with the minor cereals, their total production is far greater than that of the minor crops. However, there are certain economic and physical conditions which favor the minor cereals, either as the major crops in certain localities, or as part of a crop rotation. Since minor cereals are planted on lands not wanted for major cereals, they are not usually raised under optimum conditions. These cereals are usually low in price [1] and are of little importance in international trade.

Rye. Rye, the second best bread-making grain, is not used to any considerable extent in countries where wheat may be grown or imported cheaply.[2] Winter

[1] Cereal prices at Chicago, March 21, 1936 (from *New York Times*):

Wheat, No. 2 mixed	$1 01	per bushel
Rye, No. 2	.58¾	per bushel
Barley (May)	40	per bushel
Oats, No. 2 white	.29¼	per bushel

[2] Rye bread, as sold in the United States, contains very little rye flour and is really only rye flavored. It is quite different from the heavier breads used by European peasants.

rye will stand a moister and cooler climate than winter wheat, and is also tolerant of cold, sandy, and peaty soils. As the principal crop, it is generally associated with areas of inferior soils. Poor soils are not advantageous for rye, but rye yields do not decline as rapidly as wheat yields when poorer soils must be used.

Nine-tenths of the world's rye is grown on the extensive sandy plains which extend across Europe from Belgium to Russia. The rye map of Europe is remarkably similar to the potato map, except in the British Isles where rye is not liked Within this rye-potato belt, the areas of better soil are devoted to more exacting crops—especially winter wheat and sugar beets. Outlying areas of both rye and potatoes are found in the cool, damp plateaus in France and Spain.

In the United States, rye is used for its straw, as a cover crop, as green manure, as fodder, and for the manufacture of whisky. A few concentrated areas in Wisconsin, Minnesota, Michigan, New York, and Pennsylvania account for most of the rye that enters into trade. These centers are usually too cool for the best corn growth and generally have sandy, or sandy-loam, soils.

Oats. Like rye, oats grow well in a cool, moist climate, and although oats require better soil than rye, they can be cultivated on soil much too poor for wheat or corn. Oats are often used after wheat or corn in crop rotations, for they extract little nitrogen from the soil—in fact, oats do somewhat better in a soil without a large supply of nitrates Oats do not compete with rye for land occupance, for most rye is fall sown (winter rye), whereas oats are generally sown in the spring or summer. Likewise, oats may be grown in rotation with winter wheat, but they are comparatively rare in spring-wheat areas, except in Canada.

Oats are a well-balanced food, but are not so good for bread as rye and wheat. They are especially important as human food in cool, moist countries such as Scotland and the Scandinavian countries. Elsewhere, they are grown in large quantities for feed grain and straw. Oats are bulky and relatively perishable, and hence many farmers in stock-raising areas devote good corn land to raising sufficient oats for their livestock. Oats are also advantageous in rotation with corn, not only because they rest the soil, but because the labor required occurs at times when corn needs little attention. Oats are usually planted before corn and harvested before the corn harvest begins. Hence, in the United States, a great quantity of oats is raised in the Corn Belt, although the most concentrated production is just to the north of the most

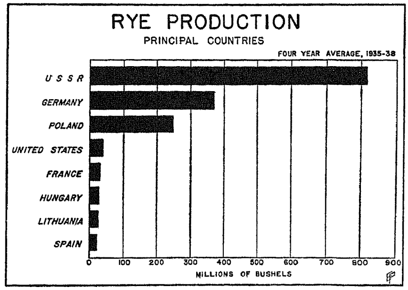


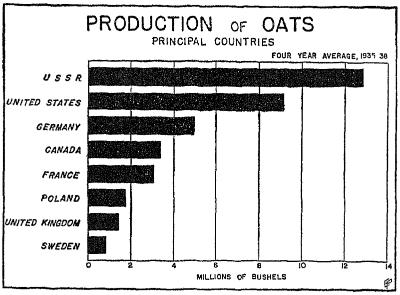
Figure 108.

intensive corn-raising area and to the south of the Spring Wheat Belt. In Europe, spring oats are grown in rotation with winter wheat and rye, especially the latter. In the warmer parts of Europe and the United States, oats are planted as a winter crop in relatively small quantities.

Barley. Barley has the broadest limits of any of the temperate-zone cereals. It is grown in Finland north of the Arctic Circle as well as in the shade of Sahara date palms. It occupies the high valleys in the bleak Tibetan Plateau and also parts of the hot plains of Hindustan. Barley has been seen growing near pools of frozen water on the mountains of Ethiopia and also in the marshy soils of the Nile Delta.

Although barley is grown throughout the temperate zone for use in malting, for fodder, and as a breadstuff, it is most important where some unfavorable environmental factor handicaps the growth of other crops. In the damp climate of Japan, it is grown on slopes too steep for rice and is one of the main foods of the peasantry. In Algeria, Morocco, and Tunis it is grown because the winter rainy season is too short for other winter grains In Denmark, the cool, damp weather prevents the growth of corn, and barley gives a higher yield than oats or rye. Barley, along with potatoes, is an important foodstuff for Denmark's intensive animal industries Barley is also grown in many parts of Europe and Asia which are subject to severe droughts—as in southern Russia and northern India. It is one of the last crops to fail under drought conditions.

In the United States, increasing amounts of barley are being grown for the use of farm animals. It is most important in the Spring Wheat Belt, in dry farming areas, and in California. Much of the American barley supply is used in brewing.



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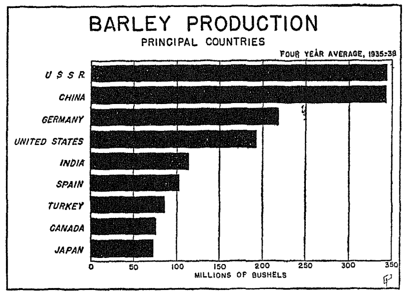


Figure 110.

Millet and Sorghum. These grains—of which there are many varieties—are exceptionally drought-resistant and play the same part in the tropics and lands with hot summers that barley plays in cooler areas In China, India, and the tropical savannas of Africa they are important human foods. But they are poor as human foods, and their presence suggests poor soils or great danger of excessive heat and drought. In the United States, they are raised only for forage on the semiarid parts of the Great Plains.

Buckwheat. Buckwheat grows in a cool, moist climate on infertile podzolic soils and rough land. Such areas are common in northeastern United States, where most of the buckwheat is produced. It grows so rapidly that it may be planted as a catch crop after other crops have failed because of early drought.

The Choice of a Cereal. The world's most popular foods have usually been the cereals, because they supply many of the elements needed in a balanced diet, give high yields in proportion to the land and labor used, and handle and store easily. Of the three most widely used cereals, wheat is most nearly a balanced food. Corn is less satisfactory because of the predominance of starch, and rice is even more starchy than corn In the ability of each to produce bulk of food per acre in physical conditions suited to it, the order is just reversed. Rice gives the highest yield, corn is next, and wheat is third. For this reason, wheat is the dominant food grain where conditions are suited to its growth and where the land is plentiful enough to be used for such a low-yield grain; corn is the food grain of people too poor to consume wheat, but with physical conditions unsuited to the growth of rice; and rice is the dominant food in regions which have the physical conditions suited to its production and a crowded population with low standards of living.

The cereal selected will be that which is most profitable under average environmental and economic conditions Perhaps it would be better to say that it is the cereal which the farmers *believe* is most profitable, for the cultural lag in the adoption of a new cereal when it is first introduced is considerable. Once people have had experience with wheat, there is a tremendous resistance to any pressure to adopt a less palatable substitute, even for reasons of economy or national self-sufficiency.

The price and the yield per acre are not sufficient to account for the popularity of a cereal. Custom, machinery available, bulk, perishability, climate, soil, place in crop rotation, government restrictions, cost of labor, by-products—such as straw and ensilage—and many other factors must be considered together in the study of the reason for the growth of a given cereal in a given field. Very few farmers ever stop to consider all of these factors—usually the crop raised is determined by what is customary in the neighborhood. If some progressive farmer tries a new crop combination which turns out profitably, others in the community gradually follow.

QUESTIONS FOR DISCUSSION

1. Under what environmental and human conditions is each of the following likely to replace wheat as the dominant cereal crop: rye, barley, oats, millet? Under what conditions is each likely to replace wheat as the principal cereal for human consumption?
2. Why are rye, oats, and barley often grown on land suitable for wheat?
3. How is the price received by a farmer for his cereal generally determined?

CHAPTER 19

CORN AND FORAGE CROPS

IN AGRICULTURAL countries with a high standard of living, half, or more, of the arable land is used to raise food for farm animals. Much of this feed is being converted into human food, but some is used for draught animals and represents, therefore, an expenditure for power. In either case, the use of a large number of animals as a part of farming is a happy combination, for the animals provide manure as well as meat, hides, and labor.

In the preceding chapters, several important foodstuffs which are also used as animal feed have already been discussed, namely, potatoes, oats, and barley. In this chapter a number of crops are considered which are used largely for animals rather than for direct human consumption. Most of these play an important part in diversified farming, since their soil requirements are such that they can well be used in crop rotations to help the soil recuperate after wheat and other soil-exhausting crops.

Corn (Indian Corn or Maize)

Long before the white man had discovered the American continents, corn[1] was the staple food of most of the natives of the New World. The ease with which it could be grown by even the most primitive methods and its relatively high yield in food per acre accounted for its importance, not only to the Indians, but also to the early colonists. The Pilgrims learned soon after their arrival how to plant corn in hills, and how to fertilize each hill by burying a fish in it. The abundant yield of their first corn crop was one of the principal reasons for the celebration of the first Thanksgiving Day.

In 1620, New England was the northern limit of corn cultivation Botanical evidence indicates that the wild ancestor of corn probably developed on the plateaus of Central America or Mexico under subtropical conditions. From its early home, the seeds were carried north and south until Indian tribes thousands of miles from the tropics learned to depend on this grain as a staple food. Some of these Indian farmers developed new varieties suited to temperate conditions, and it was one of these varieties which the Indians taught the Pilgrims to raise.

The early explorers took this prolific grain back to Europe as one evidence of the treasures of America. Its cultivation was immediately attempted in southern Europe It proved so successful that it revolutionized the agriculture of those parts of the Old World where it flourished. It is now important as far from its original habitat as China and South Africa.

Corn—the Cereal of Greatest Production. According to the best estimates of world cereal production, the production of corn usually exceeds that of wheat, its nearest competitor, by 20 per cent and that of rice by 40 per cent. Over 100,000,000 acres are used for corn in the United States, which produces nearly three times as much corn as the rest of the world. The other producing areas are the central plateau of Mexico, eastern Brazil, the Pampas of Argentina, the Union of South Africa, and the Danube, Dnieper, and Po valleys in Europe.

Physical Requirements. Corn draws heavily on the plant nutrients in the soil. The amounts of nitrates, phosphates, and potassium in the soil must be maintained at a high level to insure the best growth. In spite of these requirements, the soil is not the most critical factor, because corn is usually grown as part of a crop rotation which maintains the fertility of the soil.

Climate is the most important control over the distribution of corn. A hot, humid growing season is the strictest requirement. Bright, sunny days are almost as necessary as proper moisture, especially during the ripening season. Consequently, the humid-continental climate, long summer phase—with its summer maximum of rainfall which comes largely in convectional thundershowers, after which bright sunshine prevails—is almost ideal for corn. The nights are warm and humid—a great advantage since corn does not

[1] In England the term "corn" refers to grain in general. The name Indian corn or maize is invariably used by British writers. In Latin America and most European countries some form of the name "maize" is used.

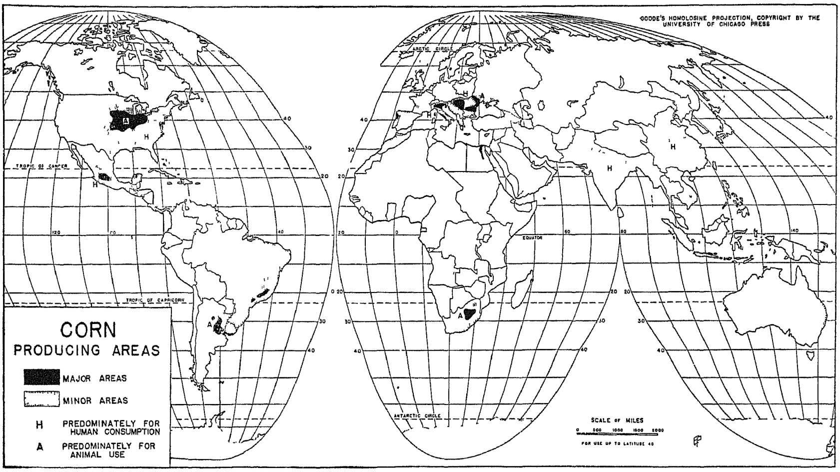


Figure 111.

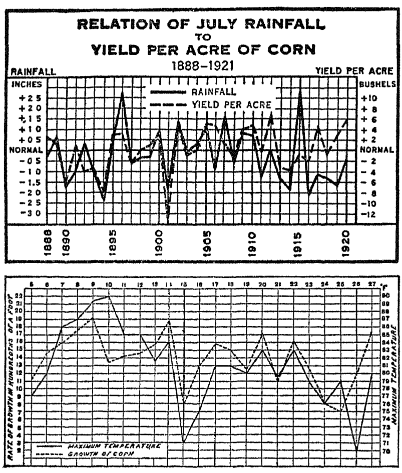


Figure 112. Temperature and rainfall fluctuations largely explain the corn yield. Other factors, such as winds, disease, pests and methods of cultivation, enter into the complete explanation. (U. S. D. A.)

thrive where nights are very cool. The humid subtropical climate has most of these features but it is not quite as well suited to corn because of the poorer soils.

Corn does best with between twenty-five and fifty inches of rainfall and with a growing season of at least one hundred and forty days. But, as with wheat, its requirements have been modified by the breeding of specialized varieties Thus Gehu corn which is grown in North Dakota ripens in ninety days while Texas varieties require one hundred and fifty days.

Corn is grown in important quantities in other climatic types, but the yield per acre is usually low. In dry climates, such as that of the Mediterranean region of Europe and some of the interior plateaus of North and South America, it is often raised under irrigation. There are also large areas within the tropics suited to corn growing. The crop does not suffer from high temperatures if they are accompanied by moderate humidity. Like many crops, it seems to thrive better near its poleward limits. The coolness of the summers prevents corn from being grown in important amounts in the marine west-coast climate. It is, therefore, excluded from most of northwestern Europe and the Pacific Northwest of the United States.

Corn is the predominant crop in many mountainous regions because it will yield much more than other grains on steep slopes and shallow soils. Although it lends itself to planting and cultivation by

machinery on level lands, it may be profitably cultivated by hand on steep slopes and is usually harvested by hand even where the use of machinery is profitable for other operations.

Varieties of Corn. One of the reasons for the wide range of the corn crop is that there are many varieties, each being somewhat different in its requirements and its product. There are more than three hundred varieties of *dent corn,* the most popular type in the great commercial corn-growing regions, where it is usually grown for feeding livestock. *Flint* types are harder than dent corn and are considered best for the production of corn meal. In many of the primitive regions of Latin America, the Indians prefer a fairly soft corn because it is easier to grind. All of the corns mentioned so far are high in starch content. This makes them large producers of calories for man or beast, but prevents them from being a well-balanced ration for man. Indeed, it is not considered wise to feed much corn to animals until they mature, when it is used to fatten them for market. *Sweet corn* is high in sugar content rather than starch, and is therefore a much more palatable human food It is a distinct type of corn, and ripens in a very short time, so that it is often raised north of the areas of commercial fodder-corn production. In the United States, it is important throughout the northern and eastern states. Maine has a specialized area for the production of sweet corn for canning. *Popcorn* is another distinct type which has a moist center surrounded by a hard shell The popping is due to the explosion of the kernel because of the steam pressure developed in the moist center.

Uses of Corn. There are really two types of corn production. The large-scale commercial production for the fattening of stock or for sale, as in the United States, Argentina, and the Danube Valley, is carried on in physical conditions very close to the optimum. But in many regions of poor soil or rugged topography corn may be the most popular crop because of its high yield of direct human food. In these regions corn is often grown very close to its limits. The Latin American uplands, central Africa, North China, southern Russia, and many other areas raise corn not because they are the best places to raise it, but because corn will yield the greatest amount of food, and these areas are capable of growing it.

Cornstalks and leaves are also used for fodder. When the ears are pulled from the plant before it is fed to animals, the product remaining is called *stover.* When it is to be used as *ensilage* (that is, corn stored in a silo where it does not dry out), it is usually cut green and the ears are not stripped off. Ensilage is especially important in dairying regions which have cold winters during which cattle may not get any other fresh, green fodder for months. It is a common practice in parts of the American Corn Belt to turn hogs into a portion of the standing cornstalks and let them feed on it. This is known as "hogging down corn."

Corn is not only important as a food but also as a raw material for a very extensive corn-products industry in the industrial countries. The 1931 Census of Manufactures reported forty-three manufacturing establishments in the United States using corn as a raw material for the manufacture of cornstarch, corn sugar, corn flakes, corn syrup, and a wide variety of oils and similar products. Cornstalks provide the raw material for the manufacture of wall board and coarse paper.

Corn and the Standard of Living. There is a direct relationship between the standard of living and the use to which corn is put. Usually, the higher the standard of living the smaller will be the amount of corn used for human food and the larger will be the amount fed to animals or converted into other products. For example, in the United States relatively little corn is used for human food, but much is fed to cattle and hogs. To this country "corn on the hoof" has a greater importance than "corn on the cob" because the population is not living so close to the subsistence level.

In southern Europe, the producing areas consume a large amount of their corn crop directly as human food, but in the more northern countries it is fed extensively to livestock and used for industrial purposes. Little is used in Germany for food, and most of her corn imports go into the manufacture of corn sugar and oil. The British Isles use a third of their imports for chicken feed, a third for cattle, and the rest for distilling and starch manufacture. Italy has no surplus for export and uses most of her large crop for human food.

QUESTIONS FOR DISCUSSION

1. Should the total consumption of corn increase or decrease with an increase in the standard of living?
2. Examine the distribution of corn growing as shown in Fig. 111. Which type of climate is present in each of the major corn regions?
3. Why is corn grown to such a small extent in central and southern China where the climate is suitable for it?
4. Why has corn, a crop which originated in the New World, become an important part of the agricultural systems of such Old World areas as Egypt and Italy?

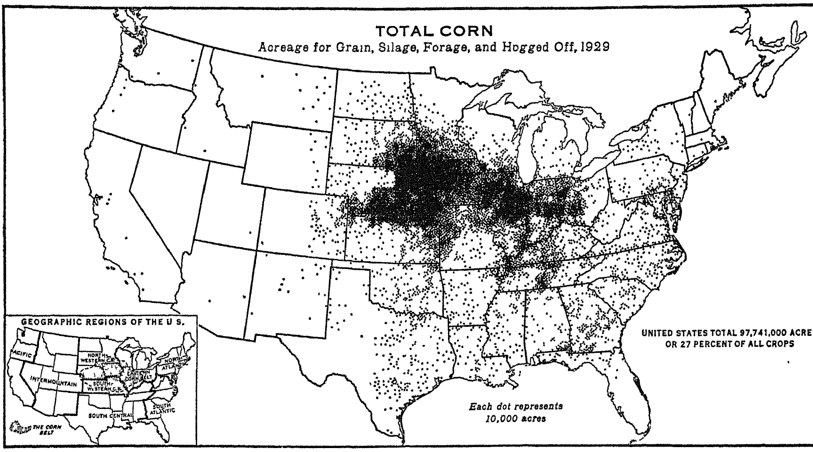


Figure 113. (Courtesy of U. S D A.)

The Place of Corn in Several Major Agricultural Regions

The American Corn Belt. Corn occupies more of the farm land of the United States than any other crop and is grown from the Atlantic to the Great Plains and from the Great Lakes to the Gulf of Mexico. There is, however, one area, known as the *Corn Belt,* which contains the largest block of land in the world having optimum conditions for corn. In this region of humid continental climate is an area of prairie soils, rich in organic material and available plant nutrients. This already rich area was smoothed to a gently rolling topography by the action of the continental glaciers. As a final gift, the retreating glaciers left a rich cover of limey material which has decomposed into deep, rich loams whose only fault was their poor drainage in many places. But man has artificially drained these areas and produced areas having optimum conditions for most grains and vegetables. It is a proof of the great value of corn that in such flexible areas it occupies half of the arable land.

The Corn Belt is in no sense solely a corn region, but it is one in which the whole economy of the farm centers around the growing of corn. It is one of the most highly developed regions of mixed farming in the world and attains a level of agricultural prosperity and living standards found in very few other areas. Here, a combination of the best in the utilization of land, crops, machinery, and animals to obtain and maintain a long-run agricultural stability has been worked out. Corn, oats, wheat, alfalfa, and hay are grown in rotation to maintain soil fertility. The crops are fed on the farm to hogs and steers which are marketed after fattening. The land is very valuable because of its large yield, and well-located farm land in this region is commonly assessed for taxation purposes at two hundred dollars or more per acre.

A Corn Belt Farm. The average farm in this region contains about 160 acres. Some idea of the "going-concern value" of one of these farms may be gotten from a study[1] of a 400-acre Illinois farm made in 1935. Although this is larger than the average and is reported to represent "the top 10 per cent," it will serve to present the picture.

The use of the land was as follows:

Buildings, yards, feed lots, vegetable garden, grape-arbor, orchard, and woods	20 acres
Pasture, bluegrass, timothy, and clover	90 acres
Alfalfa	4 acres
Soybeans (a relatively new crop in the American Corn Belt)	22 acres
Oats	124 acres
Corn	140 acres
Total	400 acres

Each year this farmer fattens and markets 75 hogs and 50 steers. His gross income averages $7000 a year

[1] "A Farm in Illinois," in *Fortune,* August, 1935

on an estimated capitalization of approximately $100,000. There is a mortgage of $10,000 The principal items of fixed and operating capital are:

Buildings, windmills, drains, and fences .	$15,176
Livestock	2,710
Machinery	3,655
400 acres of land at $200 per acre	80,000

Smaller farms would show a smaller investment in land and buildings, but perhaps as large a one in machinery. The average farm in this region is often considered to represent an investment of from $40,000 to $70,000. Most of them are mortgaged, often for more than half of their value Many are owned by banks, or small capitalists who rent them to operators.

J. Russell Smith [1] has given us an excellent picture of work on the Corn Belt farm:

> The Corn Belt farmer cannot grow one crop only and keep himself and his hired man busy Therefore, he has a crop series, which divides his time to good advantage. If his small grain is oats it can be planted while frost is still in the ground, and before corn can be planted Afterward come corn planting, corn cultivation, hay harvest and oat harvest. Then comes August, when the weeds are cut, the fences are mended and other repair work is done Now is the time for a little rest and vacation, for it will soon be autumn and corn harvest The winter is a dull season of idleness save for feeding the stock and tinkering with the machinery. . . .
>
> Corn Belt agriculture . . . is the old independent king-dom-of-my-own type, in which the farmer is nearly independent of outside labor The farmer and his sons, with perhaps one hired man, do all the work, except at harvest time when additional help is secured The hired man is often a neighbor's son and the social equal of his employer Few parts of the world, and no equally large part of the United States, can match the Corn Belt for social equality of its people.
>
> Less than 2% of the Corn Belt corn is put up in the poetic corn shock This is too much work for broad acres and few men. The corn stalks stand in the field until the ears are thoroughly dried and cured Then, in autumn and sometimes even in winter, the farmer drives into the cornfield with a two-horse wagon The horses are trained to walk astride a row of corn, while the man walks beside the wagon husking two rows as he walks, and throwing the ears into the wagon bed. Back and forth across the field they go. When the wagon is loaded the corn is hauled to the corn-crib Cattle are now turned in to pick the leavings of the fodder. This is wasteful, but it permits one man to cultivate the maximum number of acres and get the maximum output per man, although not maximum yield per acre.

The Boundaries of the Corn Belt. There are no very definite boundaries to this highly developed corn-small-grain-livestock belt, but conditions change in every direction from it. Toward the north, the growing season becomes too short for corn, while toward the west, the rainfall becomes too light. South-

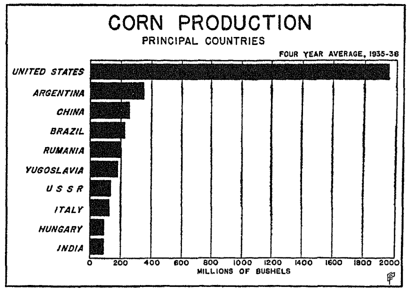


Figure 114

ward, corn continues to be raised, but is not used to any important extent for the fattening of cattle for market. The yield is lower because of poorer soil, and there is increasing danger of pests and fungus diseases due to the higher temperatures. Cotton becomes the commercial crop because of optimum conditions for it, although corn is an important hog food and human food—as corn meal, corn bread, and hominy. Toward the east, the Corn Belt merges into the poorer general farming and dairying of the less fertile soils and steep slopes of the Appalachian highlands Although corn is grown in all of the area east to the Atlantic, the emphasis changes to dairying and the production of cash crops for near-by markets.

Corn in Europe. The type of agriculture commonly practiced in the European corn belt is in marked contrast to that of the American Corn Belt farm. It has been well described in a United States Department of Agriculture bulletin [2] from which the following description of Rumanian conditions is quoted.

> The most favored cereal in Greater Rumania is corn. Corn forms the basis of the diet of the peasants, who before the war ate wheat or rye bread only infrequently. In the old Kingdom of Rumania the early maturing varieties were favored because the large landowners demanded that the fields be cleared as early as possible in preparation for the seeding of winter wheat . . .
>
> In the rotation of crops, corn usually alternates with wheat or some other cereal, but it is often planted a second year on the same field Planting takes place late in March or early in April. In Moldavia and Bessarabia the peasants sow corn broadcast upon the unplowed ground and then plow it under. When the corn thus grown is about three inches high and the weeds are still higher, the field is hoed with a semi-circular hoe, the blade of which is about 14 inches broad by 6 or 8 inches deep. The weeds and superfluous corn are then hoed out, and the plants left standing

[1] J. Russell Smith, *North America,* pp. 299-302, *passim.* Harcourt, Brace and Company, New York, 1925

[2] Louis G. Michael, *Agricultural Survey of Europe, The Danube Basin Part 2,* Technical Bulletin, No. 126, pp. 40-41.

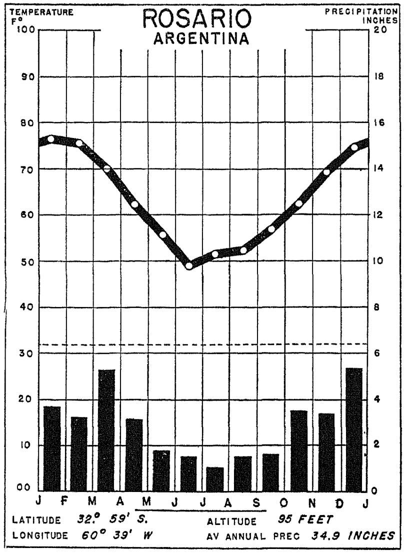


Figure 115. Climatic conditions in the Argentine corn belt Compare with Figures 76 C and 78 A, B How can you account for the difference between the humid-subtropical climate in the Northern and Southern hemispheres?

are hilled. Sometimes the peasants hoe to a greater depth than they had originally plowed, thus severing the horizontal feeding roots and injuring the plants This deep hoeing and hilling is repeated two or three times during the season In harvesting the stalks are cut off short with the hoe and thrown together in rough piles. These piles are often removed from the field too soon and consequently heat badly. Most of the peasants store corn in some sort of a crib; it is usually a basket-like affair made of woven saplings and thatched with straw.

The system of corn culture employed in other parts of Rumania is similar, with the exception that the corn is planted after the ground has been plowed. Even on large estates, few corn-planters are used Holes are made with a pointed stick at regular distances from one another, and two or three kernels are dropped into each hole.

The contrast between the two types of corn farming is striking. The Rumanian peasant raises corn first for his own consumption, then to feed his few pigs and cattle, and the remainder, if any, is exported to northwestern Europe. In Hungary, the Po Valley of Italy, and the Rhone Valley of France, corn is raised by more advanced methods, but rarely is corn in Europe fitted into a complicated and advanced system of farming such as that of the American Corn Belt. In fact, in Europe, to eat or even to raise corn is often considered a sign of poverty and, even in times of scarcity, Europeans have hesitated to lower themselves by eating what they consider "animal food."

Argentina. Northwest of Buenos Aires is an area with more than thirty inches of rainfall which might well be called the Argentine corn belt, for more than half of the land is occupied by corn. Farming there is by no means so diversified as in the American Corn Belt, but it is much more diversified than in other parts of Argentina. Winter wheat, flax, alfalfa, and swine share the use of the land. Animals, however, do not consume so much of the corn as in the United States, for the cattle are fattened on alfalfa and the number of hogs is small compared with that in the North American Corn Belt. Consequently, there is a considerable surplus of corn for export through the ports of Rosario and Buenos Aires. The corn is of the flint type, which is preferred in the markets of northwestern Europe as its small kernels make it suitable for poultry feeding. It is also drier and less perishable than dent corn.

There is six months difference between the seasons of the Southern and Northern hemispheres. Hence, the Argentine cornfields are plowed in July and August (winter), planted between October 1 and December 15, and harvested in April and May The soil consists of rich silt loams and with moderately intensive cultivation produces a fairly high yield per acre (twenty-four bushels) Droughts in poor years often greatly reduce the crop, and locusts, which arrive after the winter wheat has been harvested, often strip the cornfields. With two such natural handicaps, it is fortunate for Argentina that its corn belt is not a one-crop region.

Tropical America. From Mexico to northern Argentina, corn and beans are the staple articles of diet. This corn enters little into world trade and hardly influences world corn prices. Everyone has heard of Brazilian coffee, but few have heard of Brazilian corn, which occupies a larger acreage. Widely scattered in peon gardens and low in yield, corn throughout much of tropical America is the mainstay of a large population on almost a minimum standard of living.

Other Corn Regions. Corn is occasionally found throughout the tropical and subtropical areas of the Old World. In China, a dense population appreciates its high yield, but only in the cool north or on hilly lands does it compete with the more productive rice.

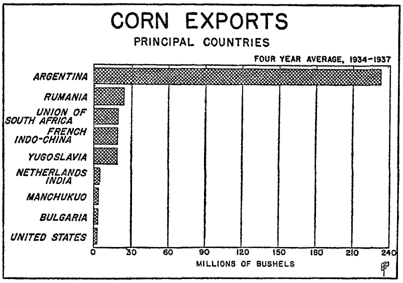


Figure 116 Compare with Figure 102 Why is wheat more important than corn in international trade?

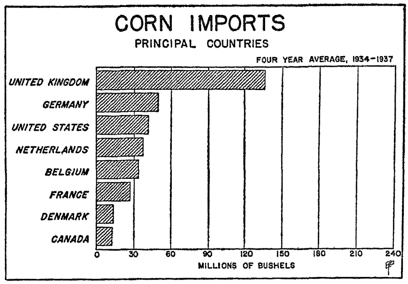


Figure 117. The importers are almost a list of the countries of northwestern Europe.

Likewise, it is important in India and Australia, but only for local consumption. A recent development is the rapid increase of corn production on the plateau of South Africa. Several thousand feet of elevation cools this subtropical area so that it is but little warmer than the American Corn Belt. South Africa is sending an increasing corn surplus to England.

International Trade in Corn. The trade in corn is small compared with that in wheat, although the production of corn is larger. So much corn is consumed on the farm, either by the farmer, or—in regions of high living standards—by the farm animals, that little goes to market. The real corn exports are corn-fed pork, beef, and lard. Only Argentina with its small population has a really large corn export. Rumania, U.S.S.R., Yugoslavia, South Africa, and the United States also export, but together they rarely equal the Argentine export. The importing countries are in northwestern Europe, and they import the corn for feed or industrial uses. The grasses or small grains raised so abundantly in northwestern Europe are excellent for the growth of young cattle, but the superiority of corn for fattening mature animals makes its importation profitable.

QUESTIONS FOR DISCUSSION

1. In the long run, which is likely to be better as a national policy, the export of corn as grain or as meat? Why?
2. Compare corn raising in Rumania with that in the American Corn Belt.
3. Will Argentina always continue to be an important corn exporter?
4. Why are the newer corn-producing countries the most important exporters?
5. Is world corn production likely to increase or decrease in the future? Explain.

Forage Crops

Hay. In countries where grass grows at all seasons, its harvest can be left to the farm animals. In most parts of the world, however, cool seasons or dry seasons prevent the growth of grass for much of the year and the farmer must store up a grass supply for the use of his stock during the season of failing pastures. This stored grass is hay—a product that rarely enters international trade, is rarely mentioned on the exchanges, and yet is a basic raw material in most diversified farming.

Natural Pastures. Many fields have thin or rocky soil and are little suited for crops. If cleared of forest and brush, they will often be occupied by a natural grass cover which, if once established, tends to be permanent. Grazing on such pastures tends to kill any trees which try to establish themselves. These pastures are common, both for grazing and for a hay crop, but they are by no means so common as the urban dweller supposes. Even more extensive are the natural pastures of the low- and middle-latitude steppe.

Artificial Pastures. There are many varieties of grass and, of these, some are superior to others for hay and for grazing. Thus, it is often worth while for the farmer to plow up his pasture lands and plant them with selected grass seeds. Even fertilizer is applied with profit to these planted pastures. Once they are planted, they need less care than other crops, but they cannot be neglected Grazing animals eat the grasses and the seeds they like best, and the weeds which are left untouched are likely to multiply faster than the grasses. This may be prevented by cutting the hay before the weeds have gone to seed.

Pastures are usually sown with a mixture of sev-

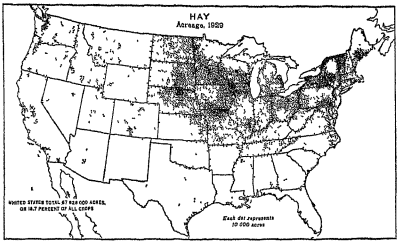


Figure 118. Hay is produced in almost every agricultural region (Courtesy of U. S. D A)

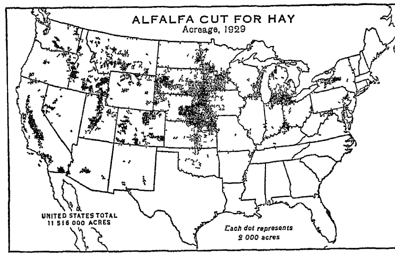


Figure 119. Most of the alfalfa areas in the east possess limestone soils (Courtesy of U. S D. A)

eral plants rather than with one. This diversifies the food nutrients in the hay as well as reducing the drain on the soil. Clover, which is leguminous, is usually a part of such mixtures because it adds nitrates to the soil. The exact mixtures used depend on the soil, climatic conditions, and local custom. Usually, the aim is to include some plant which will grow rapidly at each season throughout the growing period.

Artificial pastures are often planted on good land as part of a crop rotation. The function of such pasture plants may be to replenish the soil by adding nitrates, to provide hay, to act as a *cover crop* (to prevent erosion), or to be plowed under and add humus to the soil (*green manure*).

Alfalfa. Most hay plants are grown as part of a mixture, but the premier hay crop, alfalfa, is usually grown alone. It produces twice as much in animal food per acre as clover and, in Argentina—where it is the principal cattle food—one acre of alfalfa is considered equal to eight acres of native grasses. Hence, one-sixth of the cultivated area of Argentina is in alfalfa.

Alfalfa grows best in semiarid regions with non-acid soils. It is common in the United States in irrigated and dry-farming areas, but does not flourish in the more humid east unless the soil has a high lime content. Alfalfa has a deep-root system and can survive drought. It is also a legume. These facts, plus its high yield, account for its great popularity as an essential part of mixed farming in semiarid lands.

Soybeans. The Far East has contributed the soybean to the major fodder crops of the world. Soybeans have long been used for human food in China. They are remarkably drought-resistant, a fact of great importance if the monsoon rains slacken during the midst of the growing season. They are leguminous and provide an excellent crop for rotation with cereals. The beans have three times as much protein as wheat and make an excellent meat substitute for animal-poor China.

Recently, the soybean has taken on international importance. Northern China and the newly settled sections of Manchukuo are raising them in tremendous quantities. The beans are crushed to extract the oil (used in China as a butter substitute), and the leftover straw and bean cakes are exported for use as fertilizer in Japan and many other intensively farmed countries. The soybean has also been introduced into the United States, where it is rapidly increasing in importance as a source of fodder.

QUESTIONS FOR DISCUSSION

1. Do fodder crops improve the soil? How?
2. It is said that a good farmer can be told by the condition of his pastures What reasons can be given for the truth of this statement?

REVIEW QUESTIONS ON CHAPTERS 15 TO 19

1. Check list of new terms. Identify and illustrate each.

climax vegetation
protection forest
coniferous forest
hardwood, softwood
intensive, extensive, one-crop, diversified, and self-sufficient agriculture
increasing costs, point of diminishing returns
extensive and intensive margin, submarginal
economic rent, comparative costs
early vegetables
truck gardening
deficit and surplus regions
paddy, upland rice
spring and winter cereals
stover, ensilage, Corn Belt, "hogged down"
artificial pasture

2. Make a table summarizing the facts about the production of lumber, potatoes, citrus fruits, grapes, apples, wheat, rice, corn, rye, oats, and barley. The following headings are suggested for the vertical columns.

Climatic Requirements
Soil Requirements
Labor Requirements
Other Economic Factors
Principal Centers of Production
Nature of Foreign Trade
Other Significant Facts

CHAPTER 20

ANIMALS AND THE HUMAN ECONOMY

Animals have always been an important part of man's environment In primitive times they were his enemies, a part of his environment which had to be conquered if he was to survive. Even at this early stage, however, animals were also economically useful to man. Their meat added to his food supply, their skins provided him with clothing; their bones and sinews provided materials from which he could fashion his tools and implements and, in many instances, they were the principal basis for his religious rituals.

Animals have also provided a means by which men can use otherwise valueless elements of their environment. The minute organisms of the sea have little utility except as they are consumed by fish which, in turn, are consumed by mankind. Likewise, the grass of the pastures, the leaves and seeds of many trees and shrubs, and numerous insects are not convertible into human resources without animal intervention.

Much less obvious are other animal services: the scavenger work of jackals, hyenas, ants, and buzzards; the replanting of burnt-over areas by seeds carried by birds; the loosening of the soil by moles and earthworms.

Animals hinder as well as help. The annoyance and injury caused by mosquitoes, flies, poisonous snakes, and mice are common experience, but are probably less serious than the less obvious destructive work of pests such as the boll weevil, the Japanese beetle, termites, and the tent caterpillar. These animal pests are most serious when they move into new environments where the natural enemies which formerly kept them in check are no longer present. The greater mobility of animal life as compared with plant life makes the spread of an animal pest much harder to check. Scientists have often resorted to the introduction of other animals or of animal diseases into sections invaded by animal pests, for these natural enemies can do a much more thorough job of extermination than men could do directly.

Habitats. Men, since they have engaged in world-wide trade, have supplied their wants, in part at least, from a world-wide environment. Wild animals, on the other hand, depend upon their local environment for their sustenance. When men move into a new environment, they may build houses and create small areas with an artificial climate, they may alter their clothing and vary their diet. Wild animals are not so flexible. Except within narrow limits, their bodies are adjusted to certain definite conditions of climate and diet. Only by a long process of natural selection can animals adjust themselves to new conditions without human help. The area within which a certain species of animal lives is known as its *habitat.*

The habitats of many animals have been altered by man. He has planted more productive fodder, provided shelter against the cold and heat, and often brought water long distances or from great depths. Furthermore, many animals are now protected against their natural enemies, treated for disease, or bred to fit special conditions. Each year the area of *natural* habitats is becoming smaller and the *artificial* habitats are becoming more important.

Habitats and Migration. Many animals are so closely adjusted to physical conditions that they must migrate in order to live. The annual migrations of birds (sometimes involving a trip from the Arctic to the Antarctic regions) are the best-known example of this Many wild animals make similar—although much less extensive—seasonal migrations. Domesticated animals are often moved several hundred miles by their owners to find adequate pasture. Among the most common instances of this is *transhumance*—the moving of animals to highland pastures in summer and to lowland pastures in winter. In the Alps, for example, cattle are kept in the valleys during winter, but in early spring are moved up the hillsides to the lowest *alp* (mountain pasture). Gradually they are moved higher into the mountains until they graze on the highest alp during mid-summer. They then retrace their route and obtain a second harvest of grass from each pasture.

Hunting, Trapping, and Fishing

Hunting and Trapping. The slaughter of wild animals was undoubtedly one of the earliest ways by which man made his living. At present, the most primitive peoples make their living primarily by hunting and trapping, but they have been permitted to retain only the remote, or poorest, areas which are not needed or are not suited for more intensive occupations.

The life of a primitive hunting people is often extremely precarious. The supply of animals is uncertain, and the arrow that misses its quarry may scare away the game. If modern weapons are available, there is great danger that all of the game in the neighborhood may be killed and the tribe may have to seek new hunting grounds. This is not easy, for hunting grounds are usually considered tribal property, and migration may mean war. In spite of the sparse population, the hunting lands are often "crowded," for the carrying power of the land in such an economy is low.

Trapping is usually more certain than hunting. By setting a line of traps, the hunter is able to catch more animals because many traps are working for him at the same time. Traps, at least for small animals, are used by primitive hunters throughout the world, and most of the furs which enter into commerce are the result of trapping rather than hunting.

The Fur Trade. Three quite different types of people contribute to the world's supply of commercial furs. Best known are the primitive hunters of the northern coniferous forests and the tundras of North America and Eurasia. Valuable furs are about the only product (except precious metals) which can stand the high cost of transportation from the isolated northlands to the distant markets. A second type of hunter procures an equally important supply of pelts from the large number of small fur-bearing animals which are trapped in the woodlands and swamps of middle-latitude farming areas. Muskrat is the most important of these furs, but raccoons, skunks, foxes, squirrels, and opossums are also caught in large numbers. The Mississippi Valley is the most important center for this type of fur, and centrally located St. Louis is the principal American raw-fur market.

Fur Farming. This is not a new industry, for sheep, rabbits, and other animals have been raised for their fur since the beginnings of history. Within the present century, however, there has been a great expansion of the business, and many of the major fur-bearing animals are now being raised in captivity. Silver-fox farming has expanded most rapidly, and fox farms are becoming quite common in northeastern United States and adjacent Canada. Often the fur produced is better than that of the wild animals, and, as with all domestic animals, a more certain supply is assured.

Fishing. Fishing and hunting are major sports in almost every part of the world, but whereas hunting for food is rapidly decreasing, the spread of canning and refrigeration has made fishing an important source of human food. Nor are the fish resources of the world fully exploited. Thus it is possible that if increasing population should ever prevent the use of land for raising meat animals, fish might largely replace meat in the Occidental diet, as it has already done in overcrowded Japan.

The water of the seas, lakes, and streams is rich with plant life, much of which is too small to be visible to the naked eye. Nevertheless these organisms (collectively known as *plankton*) are—like land plants—related to the climate (especially sunlight and temperature), and their numbers decrease in the deeper and darker parts of the sea. Plankton is the food of small fish and other small animals which, in turn, are the food of the larger fish and the whales. If the environment changes temporarily, the number of plankton is diminished or increased and the fish population responds to the altered carrying power of the seas. For example, it has been discovered that an unusual amount of sunshine in the English Channel in February increases the supply of fish food and will result in a larger number of mackerel in June.

Since plant life exists only where the sunlight is able to penetrate, the ocean bottom is most densely inhabited in the shallow areas Likewise, the fish are found where the plant life is most abundant, hence the importance as fishing grounds of the continental shelves and, especially, the shallow banks (as the Grand Banks off Newfoundland). But fishing is such a hazardous and arduous occupation that it is only where the land is barren or overcrowded that man turns, from choice, to the sea for a livelihood.

The largest number of commercially valuable fish are found in the cooler and shallower parts of the ocean. The shallow banks of the cooler areas favor large numbers of a few varieties of fish—such as cod, mackerel, herring, flounder, and halibut. Tropical banks have large numbers of fish, but often only a few varieties of these are edible or palatable. Another advantage of the cooler areas is that the fish will

keep better there while they are being transported to or prepared for the market.

The principal fishing areas of the world since the period of European expansion have been the North Sea, the coasts of Norway and Iceland, and the banks of Newfoundland and New England. Dried codfish and salted, pickled, and smoked herring have always been the most important fish products in distant markets because of their remarkable ability to stand shipment in any climate. Nonmarketable fish of any sort are commonly sold for fertilizer under the name of "fish guano."

The warmer waters of the Mediterranean Sea produce other varieties of fish, of which the best known are the sardine, tuna, bluefish, and Spanish mackerel. The menhaden is also caught in large numbers, but is used principally for fertilizer. Similar fish are caught in large numbers off the coast of southern California and in other subtropical seas.

The very shallow areas along the coasts are the source of the shellfish, a term used to include lobsters, crabs, clams, oysters, and mussels. Oysters are now propagated artificially in many areas on extensive oyster farms. In Japan, oysters are often artificially irritated so that they will manufacture pearls, but these cultivated pearls are, as yet, far inferior to the natural pearls found in a few oysters.

River fisheries have decreased greatly in importance as overfishing and the pollution of streams have decreased the fish population. Many streams are now artificially stocked from government fish hatcheries; thus a supply of trout, shad, and salmon has been maintained in many exhausted streams. Salmon are the most important river fish and were formerly common in the streams draining into both the Pacific and Atlantic in the middle latitudes, but today the salmon industry on a large scale flourishes only in the Pacific area. Since salmon are hatched in the streams, descend to the sea, and then reascend the rivers to lay their eggs, they can easily be caught by placing traps along the streams. Every spring the great canneries of the Pacific Coast from San Francisco to Alaska start the canning season as the fish enter the rivers.

The greatest growth of modern fishing has been along the shores of Japan. Until the middle of the last century, Japanese sailors were forbidden to build large boats and most Japanese fishing occurred in the streams and near the shore. Many fish were cultivated in ponds (including the well-known goldfish), and thus a steady supply of fish was assured to many Japanese farmers. Since the modernization of Japan, large fishing boats have been built and the banks off eastern Siberia and northern Japan are rivaling those of Newfoundland as a source of fish. The warmer waters of southern Japan provide mackerel and tuna. With such a variety of fish resources, Japan's fishermen are not only able to supply their country with meat, but have developed an important export trade in canned fish.

The Future of Fishing. No exhaustive study has been made of the world's fish resources and much of their exploitation is on a hit-and-miss basis. In the north temperate areas, the streams and lakes have been much overfished and it is even possible that the deep-sea fisheries of the Atlantic have been overexploited As evidence of this, it is interesting to note that when the banks of the North Sea were less intensively utilized during the German submarine campaign (1915-18), the number of fish increased greatly and the fishermen's daily catch after the World War averaged much higher than it has before or since. On the other hand, many fisheries in the Southern Hemisphere are almost neglected and, although tropical resources of fish are perhaps less than those of cooler lands, nevertheless they could be much more productive than at present. Another resource is the more careful use of lakes and ponds for fish cultivation, as has already been tried with success in Japan.

Whaling. Before the use of petroleum, the whaling industry furnished the bulk of the world's illuminating oil. Hunting was so active that by the beginning of the present century most of the whales in northern waters had been killed. In 1904, Norwegians, using larger and faster ships and more efficient weapons, started whaling in the Antarctic and obtained so many animals that the destructive exploitation in the Northern Hemisphere seemed about to be repeated. However, in 1932, an agreement among twenty-five interested nations regulated the industry and placed it on a much more permanent basis. The products of the modern whaling industry are now used principally for the manufacture of soaps and leather dressing.

QUESTIONS FOR DISCUSSION

1. Why has fishing developed so little in the Southern Hemisphere?
2. Where do each of the following groups of primitive hunters live. Australian Blackmen, Eskimos, Koryaks, Pygmies? Why in each case have these people not been driven out of their hunting grounds?
3. What aspects of the environment are of most importance to animals? What aspects of the environment are unrealized by animals?
4. In what kinds of environment would you expect to find the greatest migrations of animals?

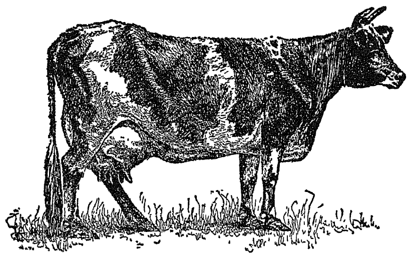


Figure 120. A Holstein (dairy type) cow. This and Figure 121 are from G. F. Warren, *Elements of Agriculture,* by permission of The Macmillan Company, publishers.

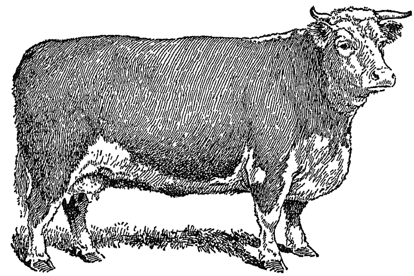


Figure 121. A Hereford (beef type) cow Compare with Figure 120. The effects of selective breeding are obvious. Environment may have also contributed to the characteristics of each animal (p 174).

The Domestication of Animals

When man attained some measure of control over his environment, he began to tame and domesticate a few of the thousands of species of wild animals. Once under his control, they were adapted still more to his purposes and used as a means of further conquest of the environment. Besides assuring him of a more certain food supply, they became one of his chief means of transportation and power. By pulling his plows they enabled him to cultivate the land better than he could by hand so that his crop yields were larger and the areas which he could bring under cultivation were increased. They also made it possible for him to deliver his surplus production to relatively distant markets.

Man's domestication of certain animals has altered radically the numbers and distribution of the various species. Out of the thousands of species, man has selected some two hundred for domestication and has caused these to multiply and spread, largely at the expense of the undomesticated species. Thus cattle, sheep, pigs, goats, and horses have increased in number, while antelopes, bison, and bears have declined.

To be considered as domesticated, an animal must not only live in captivity to man, but must breed in captivity, depend on man for food, and, in general, submit to man's will. Some wild species are almost identical with their domesticated cousins, but in animals long domesticated the resemblance between the two is often slight.

Breeding. The differences between domestic and wild varieties are largely due to selective breeding by man and to change in diet and habits. The dog was probably the first animal to be domesticated, and today dogs are as widely distributed as man. It is believed that the dog was developed from the wolf during or before the Neolithic period, but now only a few breeds of dogs have any great resemblance to their wolf ancestors. Compare the long-haired collie, which was originally a Scotch sheep dog, with the powerfully built, smooth-coated mastiff, bred as a watchdog, or with the streamlined greyhound, bred for racing. Quite different, again, are the smaller dogs used as household pets—the chows, pomeranians, pekinese, and dachshunds. Many of these varieties have been in existence for thousands of years, while other breeds are occasionally developed—and existing breeds have their characteristics emphasized—by selective breeding to win prizes at dog shows. Yet all of these diverse breeds are mutually fertile, except where difference in size prevents mating.

Draft Animals. Many of the valuable characteristics of modern draft animals are due to selective breeding. To facilitate such breeding, records of the ancestry of many of these animals have been kept for over a thousand years. Thus specialized breeds have been developed which are well adapted to particular needs.

Draft animals are of such importance to man that in Europe, much of Asia, and North America they are correlated very closely in their distribution with that of human population. This is necessarily true, for these animals are of little use unless they are kept close to work areas. Within the last few decades, draft animals in cities have been largely replaced by mechanical and electrical power. In the rural areas this replacement has been important but much less complete, and it is unlikely that draft animals will ever be totally displaced.

Cattle were the principal draft animals on medieval farms, but they have been largely replaced in Europe and America by the more efficient horse. Horses, however, are temperate-zone animals which require careful attention and good food. In the tropics and in regions of poor feed, the horse is replaced by the ox, the water buffalo, the mule, and the ass. In a few parts of the world special animals have been developed for draft purposes. In the deserts of Eurasia the camel is used as a beast of burden and a source of milk, food, and camel's hair. Only the camel can survive in the true desert, due to his ability to go for several days without food or water. A distant relative of the camel, the llama, is the beast of burden in the Andean countries of South America. It is also used for meat and wool. Elephants have been domesticated in India and southeastern Asia, and the African type is now being domesticated in the Belgian Congo. These huge tropical animals are of great potential importance, since, except for the slow water buffalo, there is no draft animal which is really suited to tropical-forest conditions Other animals that are used locally for draft purposes include the dog, goat, reindeer, and yak.

The Horse. Few animals have been as useful to man as the horse and probably no animal has been so carefully or kindly bred. For thousands of years horses have been used for pulling, riding, racing, and as a source of hides. In a few parts of the world, such as central Asia, their milk and meat are important foods. No animal except the dog has been so universally the companion of the white race.

Many types of horses have been bred, including heavy draft horses, light draft horses for general farm work, carriage horses, saddle horses, racing horses, and the pony, a stunted form adapted to poor environments. In addition, the horse has been crossbred with the ass (donkey) to produce the mule, a work animal adapted to warm lands and coarse fodder.

The horse thrives best under the same conditions which Huntington claims are most stimulating to man. Thus a large proportion of the world's horses are raised on the pastures of northwestern Europe and central and northeastern United States. Within these areas, localities with unusually fine pastures are known as centers of concentration. Perhaps the best-known is the bluegrass region of north central Kentucky, a rolling limestone area which has specialized in fine racing and saddle horses. The farms of the Corn Belt are the principal center for raising the heavier draft breeds.

The Yak and the Buffalo. These draft animals are especially adapted to extreme climatic conditions and consequently have a very limited distribution. The yak is found in the cold Tibetan plateau, where ten thousand feet or more of altitude have helped produce an almost arctic climate. The hair of this animal is unusually thick and long; his frugal feeding is well suited to the scanty forage offered by the cold grasslands. Tibet would be uninhabitable without the yak, for this animal provides the nomads with meat, milk, leather, hair, and labor. An animal of contrasting habitat is the buffalo (water buffalo or carabao) of the hot, humid lowlands of India and southeastern Asia. This slow but powerful animal pulls many of the plows in the rice fields of monsoon Asia and, in addition, supplies milk, meat, and leather of fair quality.

QUESTIONS FOR DISCUSSION

1. Are cats as varied in breed as dogs? Why?
2. How has the partial displacement of the horse by the tractor and the automobile affected the prosperity of the American farmer?
3. Look up in an encyclopedia or other source the part played by Arabia in the development of the horse.

Sheep and Goats

Optima and Limits. The sheep industry provides another good example of the general principle that extensive industries tend to be located either away from their optima or on lands which are unsuited to more intensive industries. The optimum for sheep roughly coincides with the optimum for corn, wheat, and vegetables. Because the latter produce much more in value per acre, and because the limits of sheep are wide, and they produce but a small value per acre occupied, they tend to occupy lands beyond the extensive margin of crop cultivation. Thus the more profitable uses of the land tend to displace the less profitable uses.

Sheep. Sheep are raised principally for their wool or meat, with skins and milk as decidedly secondary by-products. The two outstanding types of sheep that have been developed are (1) mutton sheep, such as the English breeds, which live in the more humid areas and produce high-grade meat but rather coarse wool, and (2) wool sheep, such as the Merino, which have a very fine, silky wool, but relatively poor meat. These two types have been crossed so as to form intermediate breeds which are fairly good for both meat and wool.

Sheep are particular in their temperature requirements, but less particular in their food and water needs. They prefer a cool climate, and where they exist in hot countries, their wool is largely replaced

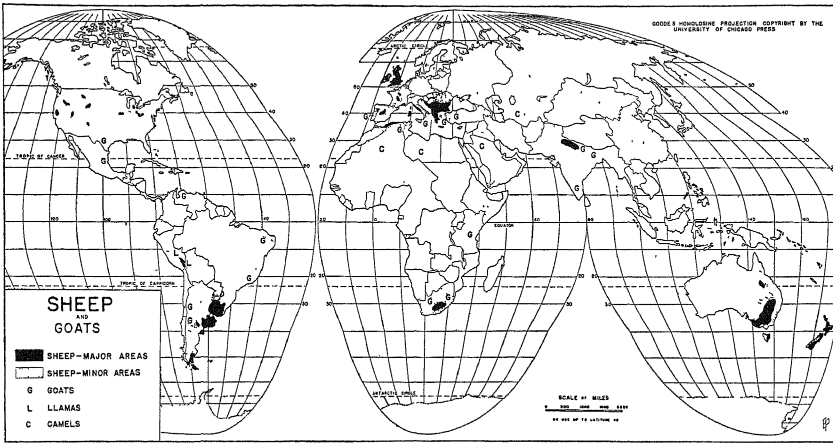


Figure 122.

by a growth of short hair. Sheep can flourish in a humid climate, provided the land is not swampy, but develop somewhat better in drier regions. They are also better suited to rugged regions than cattle. By eating the wet grass after the early-morning dew, sheep can get along with little or no drinking water. Their sharp noses enable them to feed on scattered clumps of grass in rocky crevices, and the construction of their teeth and mouths permits them to bite off grass close to the ground. This type of feeding often kills the grass and ruins the pasture, hence the common enmity between sheep and cattle raisers.

Sheep in the Southern Hemisphere. More than three-fifths of the world's sheep are raised in the temperate areas of the Southern Hemisphere. Here are relatively new countries with sparse populations and large undeveloped tracts of land suitable for sheep grazing. Before the development of refrigerator ships, sheep were much preferred to cattle because the wool could be more easily transported than beef. As sheep lands in the Northern Hemisphere were taken over for more intensive activities, the shepherds moved to the temperate southlands. Scotch, Welsh, English, and German shepherds were the original settlers in much of Australia, New Zealand, and Patagonia, and their descendants still make up a large part of the population.

But the occupation of the southern temperate lands by the shepherds was not a permanent heritage, for during the present century many southern pastures have been occupied by farmers, and the sheep tend to be relegated to the marginal, hilly, and drier areas. Refrigerator ships are now able to carry frozen mutton to European markets and mutton sheep are becoming increasingly important.

The sheep of Australia are found in largest numbers in the semiarid grasslands west of the Great Dividing Range. Here is a great rolling country with less than ten inches of rainfall and subject to devastating droughts (Fig. 123). The sheep are largely Merino but mutton sheep occur in the moister areas.

Sheep raising in Australia, as elsewhere, supports but a small population. One herder, on horseback, accompanied by a few sheep dogs can care for thousands of sheep. Every year the shearers visit the sheep corrals and in short time remove the wool, which is baled and carted to the nearest railway. Except for the supplies received from his employer and the shipment of the wool, the shepherd of Merino sheep has little contact with the outside world. Such is the business which has for several decades occupied the less arid parts of the arid center of Australia and which has made Australia the leading wool exporter of the world.

In New Zealand, sheep raising is widespread, but there is a greater concentration on the eastern or leeward and drier side of the central mountain core. The Merino type is also important here, but the damper weather has encouraged the development of

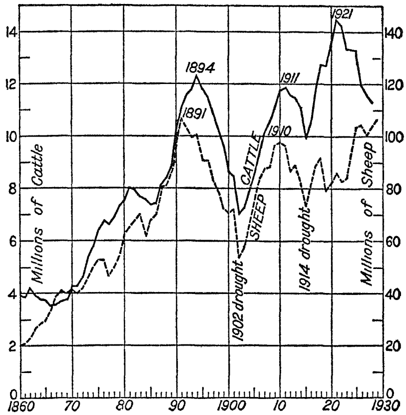


Figure 123 Growth of the cattle and sheep industry in Australia, 1860-1929 Reproduced from Griffith Taylor, "The Pioneer Belts of Australia," in *Pioneer Settlement*, American Geographical Society, New York, 1932.

mutton sheep. Lincoln (mutton) and Merino sheep have been crossed and developed into a pure breed (Corriedale), which has since 1914 been used in the United States and elsewhere. Some of these sheep are even fattened upon a supplementary diet of turnips. Thus New Zealand has become the chief mutton exporter and an important wool exporter as well.

In South America, the principal sheep-producing areas are in Argentina and Uruguay. These regions resemble closely the sheep lands of Australia in that they are predominantly flat and dry. Toward the south of Argentina, in Patagonia and in the Falkland Islands and Tierra del Fuego, sheep are becoming increasingly important. While the rainfall is greater, the increased ruggedness and lower temperatures make these areas more adapted to sheep herding than cattle grazing or field agriculture. As in New Zealand, mutton and crossbred sheep have been introduced in the moister areas and frozen and chilled mutton is now an important export.

Sheep in the Union of South Africa are found in greatest numbers in the dry highland areas toward the interior. The Drakensberg Range shuts out the rain-bearing winds and makes the interior too dry for agriculture. This is similar to the condition in Australia and, for that reason, the industry in this country has similar characteristics.

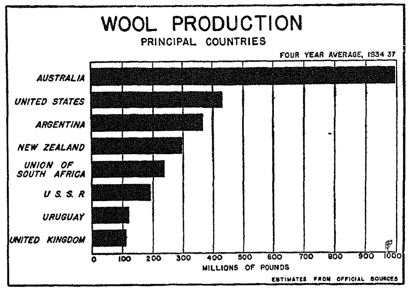


Figure 124.

The Northern Hemisphere. As sheep raising increased in the southern temperate lands, it has decreased correspondingly in the Northern Hemisphere. The decrease has been greatest in the number of wool sheep Although there are large semiarid areas north of the equator, the majority of sheep in this hemisphere are now found in the humid areas which are too rugged or too cool for the profitable production of crops. The demand for high-grade and well-flavored mutton and lamb in the urban areas has even encouraged the continued occupation of some fairly good land near the market, and sheep raising is carried on there much as the production of beef cattle is carried on in the American Corn Belt.

In northwestern Europe, most of the high-grade sheep are concentrated in England and Scotland. Formerly they were of almost equal importance in France, Belgium, and Germany as a source of raw material for the weaving industry, but the increasing pressure of population has forced them out except in a few hilly sections. In densely populated Belgium, long known for its Flemish woolens, sheep are not even listed in government statistical publications. In Great Britain, on the other hand, there are many lands which are too damp, too rugged or too infertile for intensive agriculture, and on these lands numerous mutton sheep with long coarse wool flourish. Although sheep are generally unable to endure wet lands, nevertheless they are found in rainy parts of Great Britain, partly because of the excellent drainage on the hillsides and partly because special breeds have been developed to meet various British conditions. There are lowland breeds, such as the Romney Marsh which is adapted to the diked swampy areas in southern Kent. Other breeds are suited to the chalk hills or downs of southern England, and still

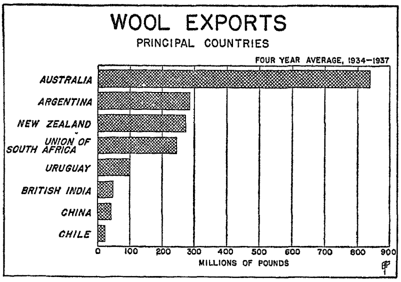


Figure 125. Note the predominance of the Southern Hemisphere.

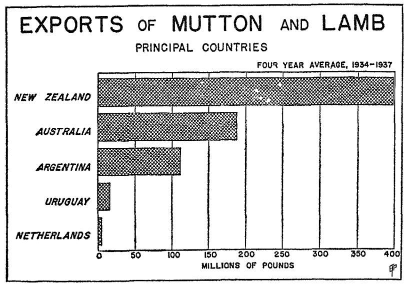


Figure 126. Why the difference in order of countries between this chart and Figure 125?

other breeds are suited to the rugged hills of Wales, central England, and Scotland. In fact, except for wool sheep such as the Merino, almost all the principal breeds originated in Great Britain

Countries with the Mediterranean type of climate are too dry for the raising of large numbers of cattle, thus goats and wool sheep which can survive in the almost completely dry summer are found in large numbers. It was no accident that the Bible, product of the Mediterranean region, emphasizes sheep and goats rather than cattle and swine. The Merino sheep originated in the high semiarid plateaus of central Spain and, like most Mediterranean sheep, are lean, hardy, highly sensitive to excessive moisture. They produce fine, silky, but short wool. Merinos have been much improved by breeding in other countries, while sheep have greatly declined in importance in Spain. In general, Mediterranean sheep now produce mediocre wool and are used largely for their meat and milk Cheese, including the well-known Roquefort variety, is made from ewe's milk.

From the Balkans eastward and northward through the semiarid and arid lands of central Asia is a great region occupied by nomads and seminomads, who raise large numbers of sheep of poor quality. In Asia especially, much of this land is little more than waste with an occasional sparse covering of bunch grass. In this belt is found the true nomad, for water and pasture are scarce and the flocks and herds soon exhaust the resources of any one locality. The products are used mainly for local consumption except for a small export of carpet wool, rugs, hides, and skins.

In the United States, sheep are nearly as numerous as swine or cattle, and this country is second only to Australia in total numbers. Approximately one-half of all of the sheep are in the semiarid, arid, or mountainous parts of the Western states, while approximately one-quarter are found in the Corn Belt and the neighboring grain and pasture regions to the north and south. The hilly lands of eastern Ohio and western Pennsylvania, New England, and the Southern Appalachians also raise sheep in important numbers. The industry in the East is somewhat like that in England, with its emphasis on lamb and mutton rather than on wool. In the West, the wool types predominate because of poorer pasture and greater distance from markets.

Goats. These animals, like sheep, are well adapted to rugged or dry areas where forage is scant. Usually the goat is most important as a producer of milk and skin and, with the exception of the Angora type, its coat is of little importance. In countries that are very arid and very rugged they supplant cattle as milk animals because of their greater adaptability.

They are distributed widely throughout the world, but are found in greatest numbers in India, the Balkan states, the U.S.S.R., and South Africa. The number of goats in proportion to area is greatest in Greece, southern Bulgaria, and European Turkey. The concentration in these Balkan countries of southeastern Europe is attributable to the exceedingly dry climate, the rough topography, and the low living standards of the inhabitants.

QUESTIONS FOR DISCUSSION

1. Do you think that the number of sheep in the United States will increase or decrease in the next 100 years? Why?
2. What is the difference between lamb and mutton? Which type of meat is likely to be most common in a wool producing area?
3. Account for importance of sheep and goats in the Balkans and the Near East.

CHAPTER 21

ANIMALS AND THE HUMAN ECONOMY (*Continued*)

THE ECONOMICS of animal industries is extremely complicated because most animals can be and are used to produce more than one product. Often a particular animal is raised primarily to serve one purpose, and the other functions performed are considered as by-products. However, in progressive communities the by-products make up such a large part of the total production that few animal producers can succeed who neglect them.

Joint Costs. The numerous by-products make it very difficult to determine the exact cost of producing any one article in the animal industries. Such problems of *joint costs* occur in many businesses, but they create special difficulties in the animal industries. Suppose that the price of meat increases and that an unusual number of cattle are slaughtered to supply the rising demand. It is obvious that a supply of leather is created also—and, in addition, perhaps as many as 140 other products. The meat may bring a high price but the price of the leather and numerous by-products may drop because such large supplies are thrown on the market. Actually the stockman cannot tell how much it costs to produce meat or how much he gets for meat; he knows only how much it costs to raise the animal and how much the animal brings. The price the packing house is willing to pay is, of course, influenced by the demand for meat and leather and possibly by the demand for other by-products.

Let us suppose that the demand for sirloin steak rises and that the price increases because of this demand. More animals may be slaughtered and innumerable inferior cuts are produced. These are sold at a price which will dispose of them, a price so low that perhaps an actual total loss may result, temporarily, from the increased demand for sirloin steaks. Such complex price and supply problems are characteristic of the animal industries discussed below.

Cattle

Cattle are used by man for meat, hides, milk, bone, manure, labor, and as religious symbols. Each use has tended to evolve its own breed of animal. Roughly speaking, however, there are five types: (1) the tough, strong oxen, developed for pulling the plow; (2) the milk cow, developed to produce large amounts of high-grade milk; (3) beef cattle, fattened to produce a large amount of well-flavored meat; (4) the semiwild steers of the pioneer regions, usually hardy, and important largely for their hides and to some extent as a source of jerked beef; (5) a great variety of breeds from Asia including the zebu, yak, gayal, and buffalo (carabao). Of these, specialized beef cattle are a recent development. Formerly, cattle raised in Europe were of a general type: the males being used as breeding and draft animals and the females for milk Meat was obtained from these animals only when they were too old for other uses or when their number exceeded the available fodder supply. Now, in progressive agricultural areas, specialized breeds are the rule and all-purpose animals are the exception. The use of oxen has declined as it has been found that, in temperate countries, the horse and the tractor are generally more efficient for farm labor. Modern breeds are, consequently, bred either for dairying or for beef.

Dairying. From the physical standpoint alone, dairying does best in a region having the marine west-coast type of climate. The warm, drought-free summers encourage a rapid growth of grass and provide an adequate supply of drinking water in the streams. The mild, humid winters allow outdoor grazing throughout the year, which not only reduces the feed bill but keeps the cattle in better health. Level or rolling land permits the cows to graze without unnecessary exertion. Shade trees should be in the pasture if hot, sunny weather is frequent, and shelter from the wind is desirable if raw, windy days occur in winter The pasture should contain a varied forage, and the soil in neighboring areas should be rich enough so that forage crops may be grown to supplement the ration obtained in the pasture.

Aside from the purely physical locating factors, the economic ones play an important part. The fact that milk is both perishable and bulky forces this

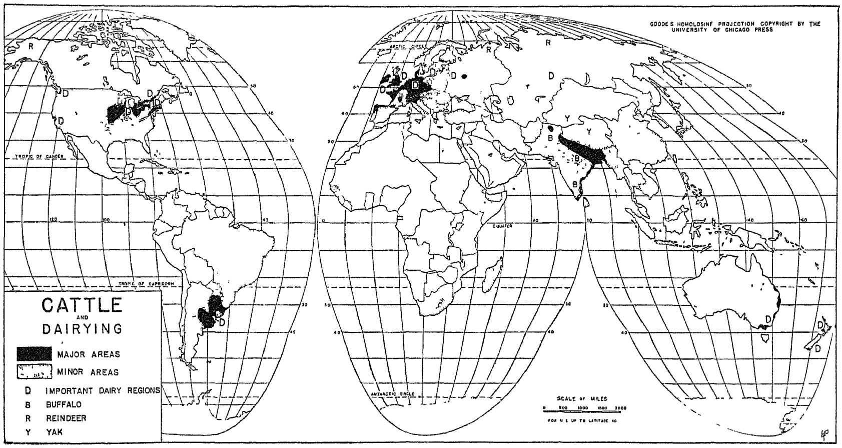


Figure 127.

type of dairying to locate close to the market. Improved transportation by fast milk trains and better roads have enabled the industry to locate closer to optimum physical conditions in recent years When the dairy products are butter, cheese, or prepared milk (evaporated, condensed, or powdered), perishability of the product is less important as a locating factor. For this reason, the dairying industry is sometimes found in rugged areas, such as Switzerland, and in these instances man has definitely molded his dairying activities to conform with the environment.

Northwestern Europe. This European area combines the optimum conditions with the world's largest market for dairy products and is, therefore, the principal dairy region. Here have developed the leading breeds of dairy cattle. A discussion of these breeds, taken from Finch and Baker,[1] provides a fine example of the different conditions under which European dairying is carried on.

To what extent the qualities of these different breeds of dairy cattle as regards form, temperament, yield, and quality of milk are due to natural conditions in the regions of their origin is not well known. Doubtless the breeders' ideals have been a very important factor in their formation. The force of environment may be seen in certain well-recognized characteristics Such are the heavy, well-muscled bodies of the Brown Swiss, required in climbing mountain pastures, and the thriftiness and ability to thrive on scant pastures of the Ayrshire breed which originated on the uplands of Ayr in Scotland, where disagreeable climate and poor, thin soils produce coarse and scanty forage The striking contrast in characteristics between the Dutch or Holstein-Friesian cattle and the Jersey is doubtless due also in part to the difference in geographic environment The native home of the Holstein-Friesian cattle is that portion of the Netherlands lying contiguous to the North Sea, where the climate is cool and moist and the soil is a heavy clay, which induces a luxuriant growth of grass carrying a high percentage of water and a corresponding low content of nutrient substance. The cows calve during the spring months, and during their heaviest milking period are obliged to obtain the needed sustenance from luxuriant but watery grass. As a result of this necessity there has been developed a cow having a large abdomen with a corresponding large digestive capacity. The cows also are large in size and their bony structure somewhat coarse and angular Perhaps as a result of these large quantities of watery food, the flow of milk is larger in quantity and lower in percentage of butter fat and other solids than the milk of other improved dairy breeds

Quite opposite are those conditions under which the Jersey cattle have developed Their native isle[2] possesses a mild climate much drier than that of Holland. The soil is a light loam and carries an herbage not abundant, but comparatively high in nutritive substance and low in water content At no time is the Jersey obliged to consume large quantities of succulent food The character of the food supply has doubtless been one factor in developing a body of moderate size and rather fine, bony structure. Environment, food, and selection by the breeder have resulted in making the Jersey cow a moderate producer of milk that

[1] V. C. Finch and O. E. Baker, *Geography of the World's Agriculture,* p. 119. Government Printing Office, Washington, 1917 This valuable publication, although based on prewar statistics, contains so much information on agricultural geography that it should be known to every student of geography.

[2] Jersey is a small British island in the English Channel near the coast of Normandy A neighboring island, Guernsey, has also given its name to an important breed of dairy cattle.

is richer in fat and in other solids than the milk of any other breed of cattle.

Cattle are raised intensively in northwestern Europe to supply the fresh meat and dairy needs of a dense industrial population. Centers of production are often located where excessive rainfall has leached the soil and left it fit for little except pasture unless intensive fertilization is utilized. In most cases, part of the food for the cattle (as corn, hay, alfalfa, bean cake) is imported, and in this way the number of cattle may exceed the carrying power of the unaided local site. The manure of the cattle is an important factor in improving the productivity of the generally poor soils of northwestern Europe.

Although dairying is important throughout northwestern Europe, the large industrial population consumes most of the local production as milk or butter and must in addition import considerable cheese and butter from less populous areas Denmark, with its small population and scientific farming, the Netherlands and Ireland, with their areas of humid pasture lands, and rugged Switzerland are the leading exporters to Germany and the United Kingdom The sparsely populated Baltic states and the U S S.R. are also exporting increasing quantities of butter and cheese.

The Southern Hemisphere. Many parts of the Southern Hemisphere have physical conditions which are ideal for dairying, but formerly butter could not stand the journey through the tropics and the necessary skill was not available for an export trade in cheese. In more recent years, refrigerator ships have made it possible to ship the butter, but it took a sharp decline in the price of wool and wheat to boom the Southern Hemisphere butter trade. Note the butter export figures in Fig. 129.

United States and Canada. In North America, dairying, like poultry raising, is distributed roughly

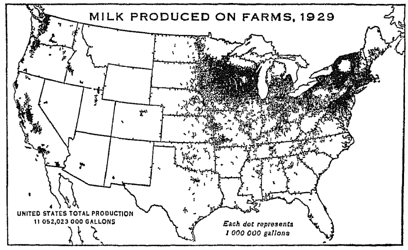


Figure 128. (Courtesy of U S. D. A)

in accordance with the population except for a few centers of concentrated, specialized production. Much of the dairying is not carried on under optimum conditions, but this is offset by nearness to a large market. The northeastern and north central states, where dairying is concentrated, have severe winters so that the farmer must provide winter shelter and feed. They have the advantages, however, of a gently rolling topography and adequate moisture. While it is often too cold to cultivate corn for grain, grass is fairly abundant and oats can be raised.

From Baltimore to Boston there extends a densely populated region whose farmers produce huge quantities of fresh milk. The demand for milk is so great that there is little surplus left for butter or cheese manufacture except in a small region in eastern Pennsylvania. When the local supply is low (milk production is subject to seasonal fluctuation), this urban area draws upon the milk supply of the butter- and cheese-producing area of northern New England and New York State.

In contrast to the fresh milk area just discussed, is a large dairy area which extends from the St. Lawrence Valley to Minnesota. Although important quan-

Figure 129

EXPORTS OF BUTTER FROM LEADING COUNTRIES

(In millions of pounds)

	Country	*Average 1925-29*	*1930*	*1931*	*1932*	*1933*	*1934*	*1935*	*1936*	*1937*
Southern Hemisphere	New Zealand	156	211	223	245	295	293	312	313	333
	Australia	100	127	191	229	212	269	257	186	183
	Argentina	50	51	51	56	31	18	15	23	19
Northwestern Europe	Denmark	311	372	378	348	332	330	305	322	337
	Netherlands	100	92	73	45	63	81	103	133	119
	Eire (Ireland)	58	59	42	37	45	57	59	58	43

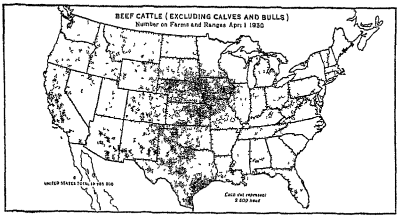


Figure 130. Cheap fodder is a major factor in locating beef cattle. Note the concentration in the Corn Belt and in the irrigated areas of the West. The small number of beef cattle in the dairy regions (Figure 128) is striking (Courtesy of U. S. D A)

tities of fresh milk are sold in this area, much of the product is converted into butter, cheese, or condensed milk. Which product is emphasized depends on the fodder available, the breeds of cows, the consequent richness of the milk, the skill of the farmers, and, often, on the reputation of the area.

Wisconsin and Minnesota provide the outstanding example of the way in which this area can be used efficiently. The area is too cool for the Corn Belt type of farming, but corn can be raised for fodder. The soil in many places is stony and poor, and the glacier left the land rugged, swampy, and dotted with thousands of lakes. Lumbermen removed the virgin forest, and immigrant farmers from northern Europe—Swedes, Finns, Norwegians, Danes, Germans, and Swiss—followed after them onto these cool farm lands. Grain farming was tried, but the soil was not good enough. Then the immigrants turned to dairying, which most of them had practiced on equally poor lands in Europe. Fortunately, Wisconsin had progressive leaders, among whom was a practical dairyman named Hoard, who founded *Hoard's Dairyman,* which became the leading dairy journal of the United States. J. Russell Smith [1] tells the story effectively:

> Hoard was elected Governor He put the machinery of the state back of the state's leading industry. The agricultural department of the University of Wisconsin became the leading dairy school of the United States. Its extension service carried dairy lore to every hamlet and farm, in its laboratories were produced five of the six tests used everywhere in dairying. One of its staff, Professor Babcock, invented in 1890 a machine for testing milk Instead of making a million out of it, Professor Babcock patented it and gave the world the Babcock Tester. By using this machine in his own barn a farmer can test the quality of the milk of every cow. The machine records the cow's history and her horoscope—it tells of her past and her future. The farmer reads that his cow's milk has 3 1% butter fat—away with her to the hot-dog factory! She is not worth milking, nor is she fit to become the mother of the next generation of cows. By the simple process of eliminating the unfit and breeding from the best sire, the average annual output of a herd of cows can, in a decade or two, be raised from 3000 to 6000 or 7000 pounds of milk per cow. Good cows occupy no more space than poor cows, nor do they eat very much more food

[1] J. Russell Smith, *North America,* p. 334. Harcourt, Brace and Company, New York, 1924

Immigration into Wisconsin brought in people who were familiar with the manufacture of all kinds of European cheese. Today, Wisconsin produces good imitations of almost every European brand—American Swiss, American Limburger, and others.

Beef Cattle. Beef animals differ from dairy animals in size and shape, diet, and the amount and type of care they require. The requirements for good beef cattle are so different from those for good dairy cattle that dual-purpose animals usually produce two mediocre products. Beef cattle have been described as shaped like a brick set on edge, whereas dairy cattle are wedge-shaped. The back of beef cattle is wide and full; the dairy cow is well developed around the udder. Dairy cattle must be housed in warm barns and given careful attention; beef cattle do better in dry, open sheds. Dairy cattle need lots of water and juicy grass; beef cattle require concentrated food and more of it. Good pasture is the main environmental requirement for dairy cattle; an adequate supply of fodder crops is most necessary for fat, tender beeves.

United States and Canada. Beef cattle are found scattered on farms throughout both countries, but there are two more concentrated types of cattle raising which are most important:

1. *The raising of cattle on the range in the semiarid, sparse-grass regions.* In these areas the carrying power of the range is very low, supporting on the average not more than ten head per section (640 acres). Of the total number of cattle in the United States in 1930, thirteen per cent were located in these areas. About one-third of the cattle kept for beef production are in these regions. They are strong but lean, and are usually sent to the Corn Belt farms for fattening before they are sent to the stockyards and meat packers. It is partly in this way that the Corn Belt farmer markets his corn "on the hoof" The range is only a grazing area and a breeding ground
2. *The raising of beef cattle on the Corn Belt farms* Many of these are range cattle, but often the Corn Belt farmer raises cattle himself, not only to reap the extra profits that are derived from the corn-on-the-hoof system, but also to increase the diversity of his farming and provide manure for his crops

The history of the livestock industry in the United States is important because all countries that are generally similar in age and environment have experienced a similar evolution. In the eighteenth century most of the country's population was scattered along

the eastern seaboard, and cattle raising was interspersed with crop production. By the beginning of the nineteenth century, population began spreading westward and cattle raising became a frontier industry, pushing west with the population. By 1825, it had largely vacated the Atlantic states and was concentrated in Ohio and Kentucky. Further expansion pushed the industry into Missouri, Indiana, and Illinois. At first, the tendency was to concentrate grazing along rivers, but eventually greater populations and their resulting demands for farm land necessitated an exodus into drier and hillier areas.

Range cattle remained in the Middle West until the development of the railroads and national highways. By the end of the nineteenth century, however, they had disappeared from the farming lands, and the range-cattle industry established itself on the permanent grazing lands of the semiarid West. Range cattle are now near their limits in a region where rainfall is almost too slight and too uncertain for crop production. Meanwhile, other beef and dairy types of cattle, fed in part by cultivated fodder, were fitted into the systems of diversified agriculture in the Middle West.

European Areas. The great beef imports of Europe have given rise to the false assumption that Europe is unimportant as a beef producer—yet the production of beef in Europe exceeds that in North America. Many European animals are dual-purpose, but there are also large numbers of beef animals raised under conditions roughly similar to those in the American Corn Belt. The animals are kept in their stalls more than in the United States, and an important amount of their fodder is imported, except in eastern Europe. The areas of greatest concentration are in Ireland and western England, the rugged highland sections—such as in southern Germany—the Hungarian plains, and Poland. The U S S R. has large numbers of poor-quality animals which are raised under conditions roughly similar to those in the Great Plains of the United States Russian beef is rarely exported because of poor transportation, and leather is the principal product which reaches foreign markets.

The Southern Hemisphere. The greatest beef-exporting region today is in the middle latitudes of the Southern Hemisphere, including (in order of their importance) Argentina, Uruguay, eastern Australia, and the Union of South Africa. Until refrigeration was developed these areas were unimportant as fresh meat producers; then the chief products were hides and jerked, dried, and salt beef.

The Argentine cattle industry includes dairy cattle (near Buenos Aires), high-grade beef cattle on fenced pastures on most of the Pampas, and mediocre, often semiwild range cattle on the semiarid regions north and west of the Pampas. The range used for beef cattle is generally superior to the grazing lands of the United States. The climate is better; the winters are mild, the summers warm and humid. Argentine cattle are fattened on alfalfa, which has proved to be an excellent fodder crop, well adapted to the rich but dry soil. Alfalfa does not require replanting every year. It has the further advantage of bringing the cattle to maturity more rapidly.

In Australia the cattle industry is similar to that of the United States in that the sparsely settled interior regions are used as grazing lands while the more humid eastern coast is important as a fattening and dairying region. Frequent droughts and poor inland transportation, however, make cattle ranching a hazardous venture. New Zealand, with a more dependable and cooler climate, has an important beef and dairy-cattle industry in those areas which are too rainy or too swampy for sheep production.

The cattle industry in the Union of South Africa has not been very successful until recently. The dry areas were better for goats and sheep, and the widespread occurrence of rinderpest, a cattle disease, made cattle raising unprofitable. The government has now brought this disease under control. With a large production of corn now available for fattening, the South African industry may well increase in the future.

The Tropics. Cattle in the tropics are chiefly important as draft animals, for meat for local consumption, and for hides. Often they are of non-European breeds and are more stringy and lean, producing mediocre hides and tough meat. They are well scattered throughout the savanna areas where man has settled,

Figure 131

LEADING EXPORTERS OF BEEF AND BEEF PRODUCTS
(In millions of pounds)

Country	*Average 1925-1929*	*1936*	*1937*
Argentina	1,553	983	1,139
Uruguay	335	180	225
Australia	284	249	308
Netherlands	238	28	37
United States	144	52	41
New Zealand	115	154	170
Denmark	28	17	54
Total	2,912	1,859	2,037

in the highland areas wherever pasture is available, and where the land is too poor for cultivation. A considerable portion of the world's cattle is found in the tropical savannas of India and East Africa, but these cattle are raised primarily for religious rather than economic reasons. For the most part, they are small and stunted. Although their numbers are great, their importance to world trade is small. They are rarely used for beef; hides and milk are their major products.

The Leather Supply. There are no breeds of cattle especially raised for leather; all breeds contribute to the supply. In general, the best leather comes from animals raised in the most advanced farming regions, not only because the skin is less subject to holes and tears, but because it is cured or tanned better and more promptly. However, the progressive countries require much more leather than can be produced from hides from local slaughterhouses and must, therefore, buy large quantities of hides from the less advanced regions. For example, in the United States nearly half of the hides consumed by the American leather industry are imported. Thus a large part of the world's leather comes from the hides of animals raised in the isolated and backward areas of the world.

The hides removed by the great packing houses at Chicago, St. Louis, Kansas City, Buenos Aires, and other large modern packing centers are called *packer's hides.* They are preferred by leather buyers because the hides are processed by skilled workers. The *country hides* are a second choice. In their preparation farmers, butchers, and ranchmen do the bulk of the work. The product may be good, but is often irregular. Those parts of the world which cannot send meat and other cattle products to the world market—the interior of Central and South America, for example—are a third source of hides. These are shipped either dried or salted. They are likely to be inferior in quality because of tick or grub damage and brand marks.

Sheepskins are also shipped to the progressive countries from the distant pastoral areas. Almost all goatskins are imported from the tropics and subtropics, especially from India. Other skins such as pig, deer (buck), ostrich, snake, walrus, and alligator are imported from a great variety of specialized producing areas.

Hides are tanned either by the use of tree products, or by the use of chromite (chrome tanning). Oak and hemlock barks are among the oldest tanning agents. In more common use today are the extracts prepared by grinding chestnut logs or quebracho logs (from northern Argentina). Sumac and gambier leaves are also important. The chrome process (developed about 1880) is especially important in the manufacture of light leathers.

QUESTIONS FOR DISCUSSION

1. The value of the hide of an animal is usually not more than one-tenth the value of the meat How does this help to explain why the United States must import leather?
2. Compare cattle-raising in Argentina with that in the Corn Belt of the United States
3. Why has the raising of cattle tended to displace the production of cereals in northwestern Europe during the last century? Has any similar shift occurred in New England and the Middle Atlantic states?

Swine

Swine (hogs or pigs) are the domesticated form of the wild hog, a forest animal which lived on nuts, berries, roots, and whatever else could be gathered from the forest floor. Like their wild ancestors, swine eat almost any sort of fodder, although they prefer rather concentrated food. They require little space and little care. Almost any climate suits them if the food and water supply is adequate. Hence the physical limits for potential swine raising are very broad. These animals are found on farms from the equator to the northernmost limits of the crops on which they feed. However, within this range, many cultural and economic factors give rise to regions of intensive commercial production, or regions where hogs are nonexistent Figure 132, which shows the distribution of principal swine-producing areas, is very revealing. The United States, western Europe, and extreme eastern Asia are regions of most intensive production; eastern South America is a region of large, but extensive production; and swine are practically absent from Africa, southern Asia west of Siam, and Australia. Large areas having no swine production are, of course, too dry for production of crops; but, in many parts having sufficient moisture to produce feed, religious prejudice eliminates the hog from consideration as a food producer. In northern Africa, Asia Minor, India, and parts of the East Indies where the dominant religions are Hinduism, Mohammedanism, or Judaism, the consumption of pork and pork products is taboo.

There are, throughout the world, three distinct types of swine regions. The one in which the animal is essentially a scavenger is common to the small

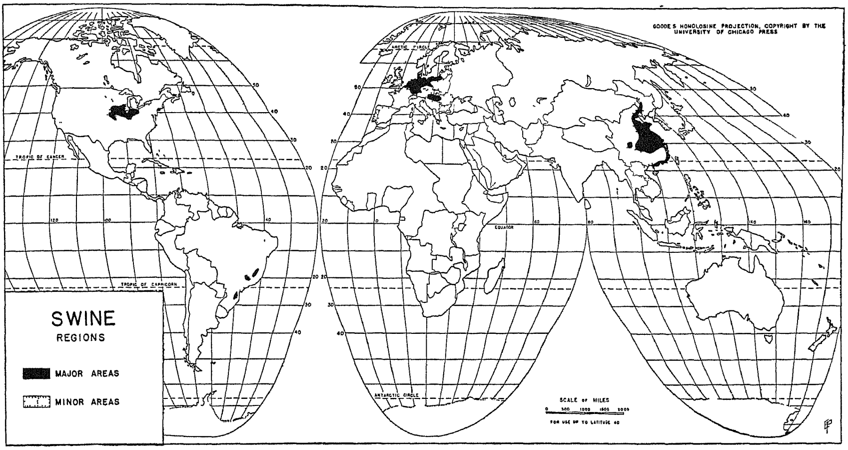


Figure 132.

farms scattered throughout the world. The hogs of this type feed on the waste products of the farm and the scraps from the household. A second type of region, notably the Southern states of the United States and southern Europe, contains the *wild* hog. These hogs are left largely to feed for themselves on *mast* (nuts and acorns that drop from the trees). The third, and most important regional type, is that in which hogs are *scientifically* bred and carefully raised.

Breeds. Two general types of scientifically bred hog are important—the lard type and the bacon type. Because of the large available supply of corn in the United States, the lard type is most generally raised, since the high oil content of the corn is suitable for developing a fat animal In northwestern Europe, the leaner, bacon type predominates and flourishes on a diet of barley, potatoes, and skim milk. Hence the two types do not usually compete for the same markets.

United States. While swine are produced on nearly 75 per cent of the farms in the United States the regions of greatest concentration are as follows: [1]

	Per Cent
Corn Belt	54
Cotton Belt	10
Dairy and General Farming Regions	7 (each)
Wheat and Small Grains	6
Mixed Farming and Tobacco Regions	4 (each)
All others	8
	100

[1] *Regional Problems in Agricultural Adjustment,* U S. D. A., 1935.

The Corn Belt is by far the most important single swine-producing area in this country. Of the 31,000,000 hogs in the Corn Belt in 1930, more than 24,000,000 were in the western part—principally Iowa and northern Missouri. Another region of concentration was the dairy region of southern Wisconsin. Comparatively few hogs are raised in Illinois, especially on farms close to Chicago. This is due to the greater profit obtained form corn as grain to be used in the corn-manufacturing industries, cheaper transportation costs for the marketing of corn for export, the emphasis on dairying, and the high price of land.

The basic factors underlying the great concentration in the Corn Belt are the presence of abundant feed supplies—grain in the central intensive feeding areas, grass and clover in the Southern pasture region, and surplus skim milk in the northern livestock section—the emphasis on diversification of crops, the greater profit to be derived from marketing corn transformed to meat, the existence of central markets and good transportation, and the economy of the animals as scavengers. The common estimate is that one pound of pork represents about six pounds of corn. In some parts of the Corn Belt the practice of "hogging down" corn is common. Instead of harvesting the matured corn, as such, the hogs are turned into the corn, and other fodder crops, and left to do their own harvesting. It is more economical to trans-

port the animals to the consuming center than the much more bulky grain.

Two distinct varieties of hogs are common to the United States In addition to that which is common to the Corn Belt, there is the "wild" hog, or *razorback,* of the Southern states. But the pork of the Corn Belt is preferred in most markets and brings a higher price than the soft, oily pork of the South. In recent years, increasing attention has been paid to the raising of hogs on farms in the South. Corn feeding has not gone very far, however, as it is estimated that but 2 bushels of corn are fed per 100 pounds of pork in the South as against 7 to 8 bushels in the Corn Belt. Some of this difference is accounted for by the feeding of peanuts in Virginia and the Carolinas which produce hams of high quality.

Northwestern Europe. The dairy farmer can convert about 4 pounds of every 100 pounds of milk into butter and has left 96 pounds of skim milk for potential hog feed. Thus, in northwestern Europe, as in southern Wisconsin, the dairy industry has swine raising associated with it as a consumer of by-products. Potatoes and other root crops and barley are added to round out the hog's diet. The product is ham and bacon of the finest quality which brings several cents more per pound than American bacon. Some European bacon is even exported to the luxury markets of the United States All northwestern Europe produces pork products, but Denmark and Ireland have a sufficient surplus to export large quantities to the United Kingdom and other industrialized areas

Other Countries. Hungary, Rumania, and southern Russia are important producers of lard-type hogs, for these countries include parts of the European Corn Belt. In the Mediterranean countries, the hogs are raised in much the same way as in the American South. They are of the wild type and are left to forage for themselves on the mast from the chestnut and oak trees in the forests.

The only other countries of primary importance in swine production are China, the Philippine Islands, and Brazil. Relatively little is known of the swine industry in these countries. In Brazil, both "culti-

Figure 133.

NUMBER OF HOGS AND INTERNATIONAL TRADE IN HOG PRODUCTS
PRINCIPAL EXPORTING AND IMPORTING COUNTRIES

Countries	*Hogs (in thousands)*		*International trade (millions of pounds)*			
	Average 1926-30	*Average 1934-38*	*Average 1925-29*		*Average 1933-37*	
			Exports	*Imports*	*Exports*	*Imports*
Principal Exporters						
United States	56,844	45,290	1,137	10	384	26
Denmark	3,741	5,101	557	3	510	‡
Netherlands	2,018	1,641	249	15	124	4
Canada	4,387	3,760	91	17	161	4
Eire (Ireland)	1,048	993	93	55	73	‡
Poland	5,736	7,211	48	37	93	‡
Argentina	3,769	3,976 †	9	‡	57	‡
New Zealand	525	755	13	‡	56	‡
Sweden	1,574	1,552	41	10	37	6
Total Principal Exporters	79,642	69,279	2,297 *	152 *	1,614 *	42 *
Principal Importers						
United Kingdom	2,879	5,366	6	1,372	4	1,294
Germany	19,715	23,917	5	322	‡	176
Cuba	591	903	0	130	0	30
Czechoslovakia	2,814	3,212	4	80	‡	31
Belgium	1,159	1,164	7	22	5	16
France	5,942	7,012	3	88	4	13
Total Principal Importers	33,100	41,574	34 *	2,184 *	34 *	1,596 *

* Includes other principal exporting or importing countries.
† Year 1937.
‡ Less than 1 million pounds.

vated" and "wild" hogs are common, in the Philippines, hogs are allowed to run wild or are kept as scavengers; and in China, the latter type apparently prevails

Poultry

From the edge of the polar regions to the heart of the rainy tropics, and from the crowded farm lands of China to the sparsely populated nomad lands, poultry is kept by man for meat, eggs, and feathers. Little room is required for it, and it can utilize small resources which no other domestic animal can use. It is a scavenger, too, for it lives literally on the "crumbs" from the tables of people and large domestic animals and on the insects and worms which no other useful animal will eat. The poultry industry is the most universal of animal industries, and its importance is quite out of proportion to the attention usually given it by students of business. In the United States, its annual product has frequently exceeded $1,000,000,000—a figure which, in 1933, was about equal to total receipts from the slaughter of cattle and hogs.

Poultry is generally raised in comparatively small numbers per farm on large numbers of farms throughout the world. However, its production is especially concentrated near cities, where the demand for these products is greatest. As with many other agricultural industries, the development of improved transportation and mechanical refrigeration has greatly influenced the distribution of the poultry industry; and specialized poultry farms, often away from the local market, are becoming increasingly common.

United States. In the United States there are three major areas of poultry specialization. One of the important ones is in southeastern Pennsylvania and adjacent parts of neighboring states. The poultry industry, here, is found on poor soils or on rolling areas which are not especially suited for cultivation. Proximity to the Eastern urban markets has, of course, been a major factor. The second, and much larger, region is in and around the Corn Belt. There, poultry is often raised as part of diversified farming and the cheap feed from the Corn Belt farms is a controlling factor. Eggs from the Corn Belt are shipped as far as New England and are an important source of supply for the cold-storage warehouses. The third center is Sonoma County, California (just north of San Francisco Bay), which supplies the California urban markets and also ships a few white eggs of unusually high quality to Eastern markets. However,

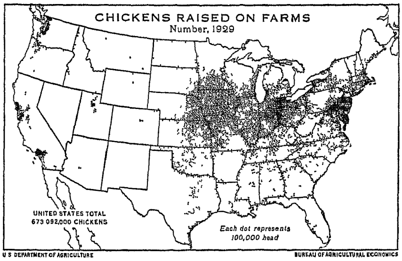


Figure 134.

the mention of these specialized areas does not imply that poultry farming is not important elsewhere, for the poultry map of the United States shows that poultry is distributed, with the exception of the three regions noted above, approximately in proportion to the population.

Poultry Breeding. Although many flocks receive little care, there are few industries where careful attention will yield greater returns. As in other animal industries, there are different breeds of poultry depending on the principal product desired. Ducks, geese, and turkeys are invariably raised for meat; but chickens are divided into three types: meat breeds—such as Brahma and Cochin, egg breeds—as Leghorn and Minorca, and general-purpose breeds—as Plymouth Rock, Wyandotte, and Rhode Island Red. In addition to these, there are special varieties raised for ornament or for cockfighting. In the United States, the general-purpose breeds are most common, although Leghorns are also popular for their egg-laying value.

Denmark. Danish eggs today lead the world both in quantity and quality in foreign markets. The rise of the Danish egg industry is the result of intelligent cooperation among Danish farmers (with considerable government encouragement), for Denmark is no better suited than other parts of western Europe for the industry. Indeed, considerable quantities of corn are brought in from Argentina, and other feeds are also imported.

Quality is the secret of Danish success in foreign markets. Not only are the chickens of the best breeds and their feed and care the most scientific to be found anywhere, but stringent rules control the quality of products of the Egg Export Association to which most poultry raisers belong. Each egg must be carefully inspected by the farmer and stamped with

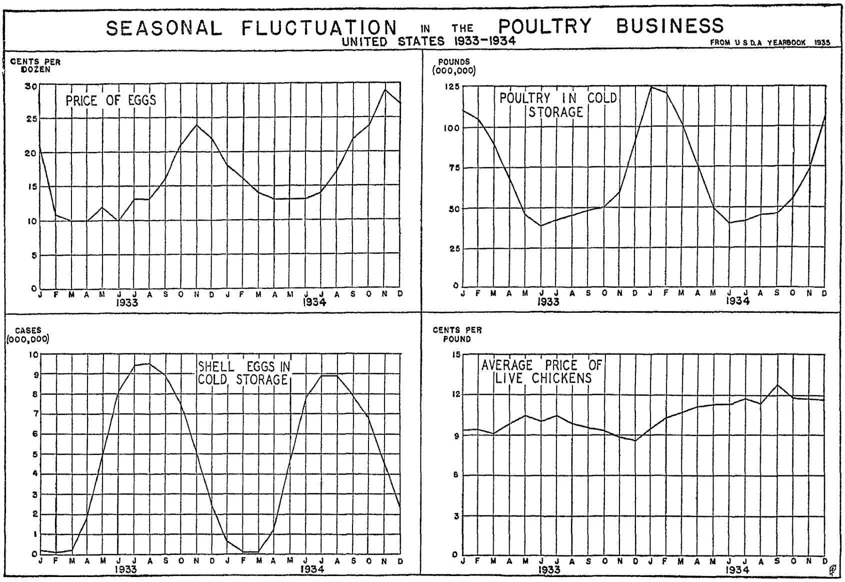


Figure 135. Similar price fluctuations occur in many foodstuffs.

his number. If any egg turns out bad, it is a simple matter to trace it to the farm of origin.

Dried and Frozen Eggs. In contrast to Denmark are the large numbers of eggs exported from China, Turkey, and the Balkans. Most of these are the produce of hens who forage for themselves on the farms and produce eggs of the poorest quality. Factories at the ports convert these eggs into egg powder and frozen eggs (usually shipped without the shell) which are exported for use in the manufacture of low-grade bakery products.

Seasonal Fluctuations. The production of eggs varies greatly according to the season, and the price fluctuates accordingly (Fig. 135) Spring weather seems to be most favorable for a large production, probably because of the increasing temperatures and the longer days, which result in an increased period for feeding. The cold, short days of December cause the hens to spend a large part of the time in their roosts, and egg production is low. Artificial lighting for a few hours in winter will increase the hens' activity and eliminate part of the winter decrease in egg production.

When eggs are cheap and plentiful, large numbers of eggs are put in cold storage. This is profitable, as these cold-storage eggs may be sold in the winter at a price which exceeds the spring price for fresh eggs plus the cost of storage. Likewise, chickens raised for meat are often slaughtered in early winter and kept frozen in storage. Chicken is often low in price at this time, as farmers do not wish to incur the heavy expense of keeping large numbers of chickens through the coldest months when their egg production is low.

QUESTIONS FOR DISCUSSION

1. Compare the distribution of swine and beef cattle. Explain the similarities and differences.
2. Why does the United States both import and export hog products? The Netherlands also imports and exports hog products. Is the reason the same?
3. Would the production of poultry and eggs for export be a good business to develop in Argentina? Would such a business affect the seasonal fluctuation of prices in the Northern Hemisphere?

CHAPTER 22

COTTON AND OTHER VEGETABLE FIBERS

THE FIBER and textile industries have always been strongly competitive. This competition has occurred not only among the various producers of each fiber, but among the fibers themselves. Thus flax and wool, the oldest of the textile fibers in Europe, were partially displaced by cotton in the nineteenth century and later by silk In turn, silk and cotton are being partially displaced by rayon, and there are many potential fibers which may still enter the race. Changes in style also do much to add instability to the textile industry.

The international trade in textiles and textile fibers is large. This is partly because each textile fiber has its producing area concentrated in relatively few countries, although the consumers are found throughout the world. For example, 85 to 90 per cent of the world's cotton crop is produced in five countries; 90 per cent of the world's silk production is concentrated in Japan and China; while jute is practically a monopoly of India. In addition, the consuming areas are frequently far from the producing areas. Finally, small differences in the raw material and the design and quality of the finished product add to the extensive international trade. Thus, the United States imports long staple cotton and English broadcloth, and at the same time exports upland cotton and American broadcloth.

Cotton

The importance of cotton in modern life is probably but vaguely realized by the majority of people. In the United States, cotton is consumed at the rate of nearly twenty-five pounds per capita each year. In international trade, cotton outranks all other agricultural commodities. The value of the world's cotton trade is approximately 6 times that of silk, 2½ times that of wool, 1¼ times that of sugar, and about equal to the trade in wheat or meat products.

History and Uses. The cotton plant is of very ancient origin, antedating all recorded history. It is supposed to have originated in India, and in ancient history was spoken of as "tree wool." The people of India acquired great skill in weaving cloth from cotton fibers. Historical accounts mention plants similar to cotton in the various countries of southern Asia and Africa. Columbus and other explorers who visited the Western Hemisphere found native cotton growing in the West Indies and tropical South America. Cortez found a flourishing textile industry among the Aztecs in 1519, and in Peru, Pizarro found cotton garments said to antedate the civilization of the Incas.

Cotton has not always been the cheap textile it is considered today. Formerly it was necessary to separate the fiber from the seed by hand, and five pounds of cotton lint was the common daily output per worker. Prices were high, and cotton cloth was often adulterated by adding wool or linen. The invention of the cotton gin (1793) cheapened the task of seed removal, and the invention of efficient spinning and weaving machines during the Industrial Revolution further lowered the price of cotton cloth. Improved and cheaper transportation from the cotton fields to the industrial regions and the utilization of the seed for oil and oil cake helped to reduce further the price of cotton goods and thus widened their market.

The uses of cotton, both as a textile and otherwise, have also expanded. Better heating systems and the increasing urbanization of the world's population have made possible the use of lighter weight clothing, even in winter. Improved finish and design have popularized cotton frocks for summer wear. Cotton is also used in industry in the manufacture of cotton batting, explosives (gun cotton), and as a source of cellulose. Cottonseed oil is used as a salad oil and as an adulterant; oil cake is used as a fertilizer. But the amount of cotton lint used for nontextile purposes is small. The recent surplus on world markets has caused producers to seek additional uses—such as adding the fiber to pavement to strengthen it, using it in the manufacture of paper and as a raw material for rayon and other products.

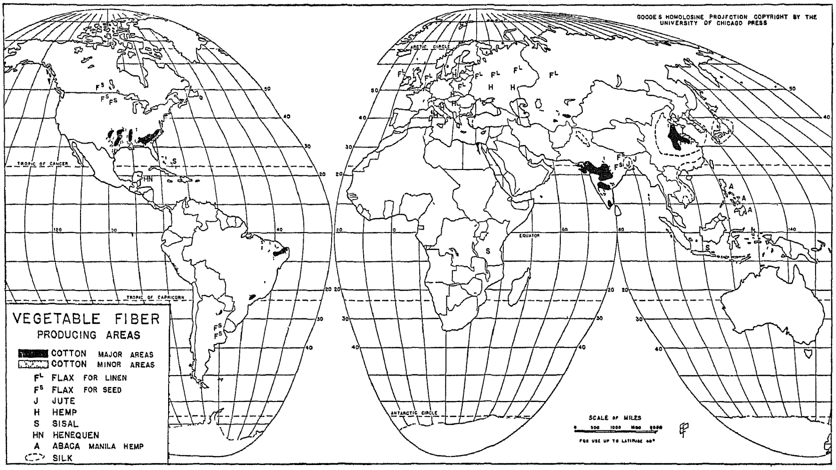


Figure 136.

Cotton Varieties. The price and use of cotton lint vary greatly with the variety and the condition in which the product reaches the market. The latter factor depends largely on the care used by ginners, packers, and shippers, but the variety is based on more fundamental conditions. Each variety is closely adjusted to special soil and climatic requirements and cannot be planted at random in any cotton region.

Although silkiness and color influence the price of cotton lint, the most important determinant is the length of the staple. The greater the length of each fiber, the greater will be the overlap in spinning the threads, and hence the thread will unravel less easily and be stronger.

Climatic Requirements. The original home of the cotton plant was in the tropical-savanna type of climate. It was perennial but died down every year during the dry season after ripening its bolls. In the middle latitudes it is necessary to replant it each year. In many parts of the tropics also this practice is found to give better results, as it permits deeper plowing and destroys insect pests and plant diseases. Although the principal producing areas are now outside the tropics, cotton requires a climate during its growing season which reproduces tropical-savanna conditions.

Cotton cannot be readily grown where the average summer temperature is below 77° or 78°. For the best growth, both night and day temperatures should be high, and the mean July temperature should range between 80° and 90°. Cotton, being a slow-growing crop, seldom matures in less than one hundred and eighty days, while the growing season is usually considered to be two hundred days. Like all warm-weather crops, cotton is subject to damage by frost in the fall, especially when as a result of unfavorable weather the development is slow during the growing season. There is a close relationship between the temperature during the early period of growth and the time at which cotton matures.

Cotton needs a moderate but regular supply of moisture; hence frequent light showers, with plenty of sunshine between them, produce the best condition for its growth. The mean annual rainfall in the Cotton Belt of the United States varies from twenty inches in the important cotton area in Texas to fifty inches or more in the central and eastern areas. Desert areas with abundant water for irrigation are almost ideal, for under these conditions there is adequate moisture and sunshine. Most fine-grade cotton comes from irrigated regions.

Cotton is drought-resistant; in fact, a complete crop failure due to drought is almost unknown.

Whereas in semiarid wheat areas the harvest is often completely lost, in the Cotton Belt a dry year usually diminishes the crop not more than one-third. Cotton has the rugged characteristics of a weed. Due to this fact, and also owing to the long season during which growth and fruiting take place, there seems to be no comparatively short period in the development of the crop in which unfavorable weather is likely to prove disastrous. Even a long period of unfavorable weather does not necessarily injure the plant, which grows rapidly with the return of good growing weather.

There are certain well-defined weather conditions, however, which may either hinder or promote growth. Rainy or cold weather early in the season hinders the preparation of the soil and the planting of the seed and proper germination; excessive rainfall in the first part of the season not only prevents proper cultivation but encourages shallow root development; dry and hot weather later in the season is very detrimental, as is heavy rain during the harvest season.

Soil Requirements. The cotton plant will grow on a variety of soils, but a fertile or heavily fertilized soil is necessary for profitable results. Well-drained alluvial soils are considered best, but are of limited extent. Medium loams with a clay subsoil at a depth of about two feet are generally the next best. Too sandy a soil fails to hold water, while a heavy clay holds too much water and encourages a heavy growth of leaves.

Cotton is often grown on rolling lands and this, combined with the continuous leaching which goes on in subtropical and tropical areas, makes soil conservation a difficult problem. Many cotton fields have suffered permanent loss of fertility because of careless treatment. The wise cotton farmer finds it necessary to prevent gullying and soil erosion by constructing low terraces, and to add large quantities of fertilizer each year.

Labor Requirements. Cotton has always been associated with cheap labor—a fact which was largely responsible for the long continuance of slavery in the South. Much of the work in the fields—weeding, cultivating, and especially picking—has until recently been done largely by man power. Many tasks which could have been performed by machinery were done by hand because labor was cheap, and because it was considered necessary, in the moister parts of the Cotton Belt, to have the labor supply on hand anyway for picking. When cotton growing expanded westward into the drier and more sparsely populated areas, machinery began increasingly to be used for all pre-picking operations, and a migratory labor supply was imported for the harvest. Many attempts have been made to devise a satisfactory machine to pick cotton but, as yet, only partial success has been attained. Agricultural machinery is most suited to use on flat or gently rolling lands and has thus been most successful in the American Cotton Belt on the Texas and Oklahoma plains and on the bottom lands of the Mississippi. Labor has always been one of the real barriers to expansion of cotton production in such "new" cotton areas as Brazil, Argentina, and Australia, and the development of a successful cotton picker with the resultant possibility of an almost complete mechanization of the process would undoubtedly react to the especial benefit of such areas.

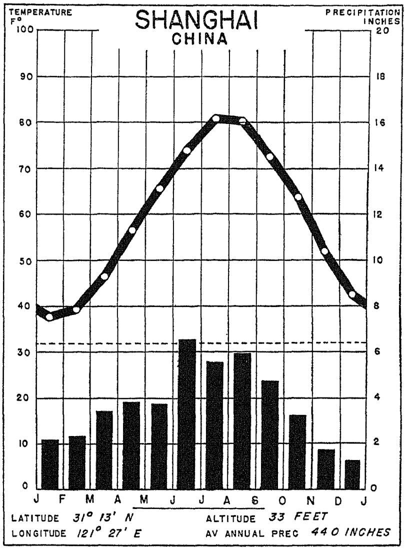


Figure 137. Climatic conditions in the Chinese cotton-growing area Compare with chart of Columbia, S. C, on page 109

Cotton Pests and Diseases. The cotton plant is most susceptible to insect pests and plant disease. Figure 138 gives striking evidence of this from the cotton crop of the United States. The seriousness of the problem is increased by the common practice of growing cotton on the same field year after year, thus enabling the insects and diseases to get a firm foot-

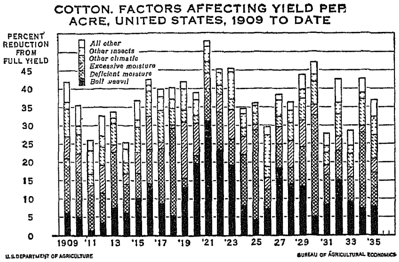


Figure 138 (Courtesy of U S D. A)

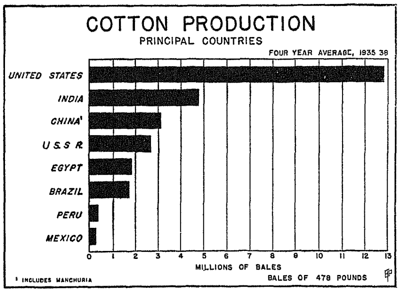


Figure 139

hold. The worst of these pests, the boll weevil, has driven Sea Island cotton from its former principal producing area (the coast of South Carolina and Georgia) and is responsible for much of the westward migration of American cotton production. Sea Island cotton is now grown on the small islands of the Lesser Antilles—but even these islands are occasionally attacked by pests. The remedy there is fairly easy—cotton cultivation is discontinued for a full year and every cotton plant is burned.

QUESTIONS FOR DISCUSSION

1. Do the wool- and cotton-producing areas coincide to any considerable extent? Explain
2. Why do the United States and China both export and import raw cotton?
3. Within what types of climate is cotton raised? Compare the climatic chart for each (pages 105-109) with the climate requirements described above.

The Regional Geography of Cotton

The International Market. Almost no product is so widely used as cotton cloth—it serves alike in the millionaire's shirt and the loincloth of the Hindu coolie Few raw materials are so widely manufactured. It is fabricated not only in the great mills of Lancashire and on the primitive looms of Indian villages, but every country that has any claim to industrialization produces cotton textiles. Yet, of the leading cotton-manufacturing nations only the United States and the U.S.S.R. can supply all of their own needs; many important textile producers such as France, Italy, Czechoslovakia, Germany, and Sweden depend entirely on foreign sources of supply for their raw material. International competition is so strong, however, that there is little danger in peacetimes that the cotton-deficit countries will suffer as did England during the American Civil War. At that time, 85 per cent of the British cotton supply was cut off by the Northern blockade and nearly $10,000,000 was spent in Great Britain for the relief of textile workers thrown out of employment.

The United States. In the South, cotton is king. Its predominance in the Southern economy as a cash crop and as the principal export was responsible for shaping the economic planks in the platforms of Southern statesmen throughout most of the nineteenth century. Slavery, free trade, and states' rights were all conditioned by cotton. Even today the prosperity of many Southern rural communities fluctuates directly with the return from the cotton crop.

The poleward limits of cotton growing in the United States follow roughly the mean summer isotherm of 77° where the frostless season is less than two hundred days on the north, while the western limit is marked by the twenty-inch isohyet. Very little cotton is grown in southern Florida or the immediate coasts of the Gulf states, owing in part to very sandy soils and in parts to the increasing autumnal rainfall which interferes with ripening and harvesting.

Most American staple crops have a wider geographic range than cotton. Hence in those areas where it can be grown fairly near the optimum, cotton predominates over other staple crops which yield less in cash return per acre. In addition, cotton requires labor and the use of machinery pretty well throughout the crop year, thus further tending to discourage the growth of other crops on cotton farms. Approximately one-third to one-half of Cotton Belt crop land is in cotton, about one-fourth in corn, and the rest in soybeans, velvet beans, cornpeas, peanuts, vegetables, fruit, or is left lying fallow.

Cotton farms are usually small. After the Civil War most large plantations were divided into tenant

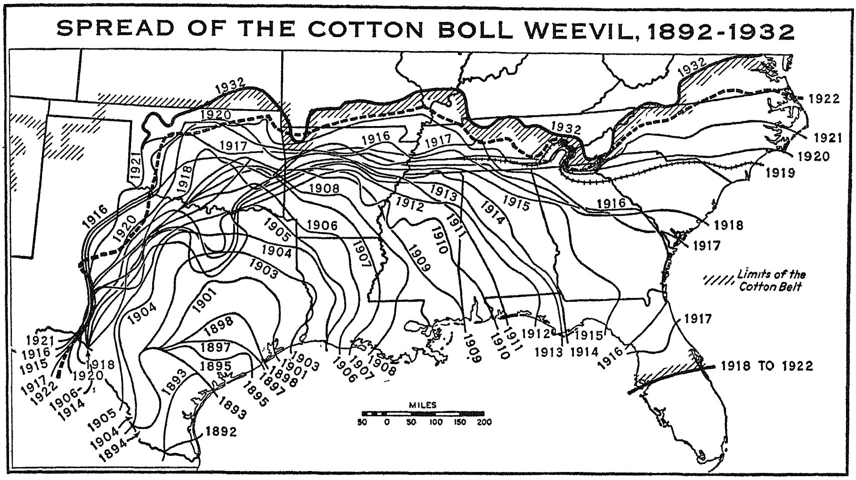


Figure 140. Compare with Figures 138 and 141 (Courtesy of U S D A)

farms, each operated by a Negro tenant and his family. Today the amount of cotton raised is usually limited by the amount of labor available in the family. The labor problem is especially critical at harvest time, and the tenant usually roughly determines his acreage by his ability to get it harvested. The plantation performs many services for its tenants, such as advancing food supplies and seeds, lending tools, and often ginning and marketing the cotton.

Although the South is most certainly the "land of cotton," this staple crop is by no means evenly distributed there. The areas of concentration are largely based on soil belts. The oldest plantations were located on delta lands along the coast, on the light sandy loams in the inland strip of the coastal plain, and on a parallel strip on the somewhat more fertile Piedmont, the last two strips separated by an infertile area of sand hills. The increasing demand for cotton soon started a westward expansion into the Black Belt of central Alabama—an area of dark, fertile, limey soil—and into the rich bottom lands of the Mississippi Valley. Further expansion led to the occupation of the Black Waxy Prairies, a soil belt similar to the Black Belt of Alabama and extending roughly from north of Dallas to San Antonio, Texas. The last twenty years have witnessed a further westward movement to the semiarid parts of Texas and the irrigated

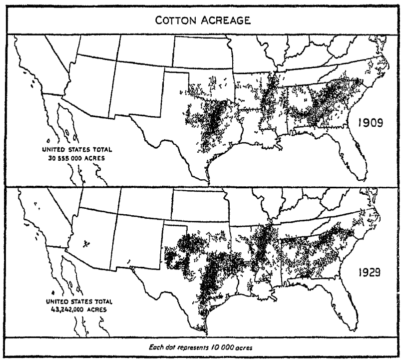


Figure 141. (Courtesy of U S D. A.)

lands of the Rio Grande Valley, Arizona, and Southern California. At the same time, considerable cotton acreage has been abandoned in the older cotton areas.

The reasons for this last shift are well known. The most spectacular reason was the invasion of the boll weevil which entered the United States from Mexico in 1892 and by 1922 had infested every humid part of the Cotton Belt. Its ravages have been partially pre-

vented by growing early-maturing varieties and by spreading calcium arsenate dust. The latter method is best applied in drier areas, since heavy rains wash the poison from the plants. Another reason is the decline in soil fertility in the east due to a century or more of one-crop cotton farming. This tendency has been aggravated by inadequate fertilization due to low cotton prices in recent years. Finally, partly as the result of weevil infestation and partly because of the demand for other crops in the Southern industrial areas, many cotton farmers in the Southeast have diversified their crops.

The economics back of this westward shift will be more obvious if some concrete figures are examined. In Fig. 142, the lower cost per acre for fertilizer in the western areas is striking. Furthermore, Texas farms have a lower labor cost because machinery can be used more readily on the plains than on the rougher surface of the Piedmont. Thus in spite of the lower yields per acre in Texas, the lower costs of production give that state a per pound advantage which is greater than the additional freight charges to the industrial regions.

The long staple regions are included in Fig. 142 to show how intensive is the cultivation on the limited lands suited to these varieties. The higher cost per pound is more than offset by the premium paid for the longer staple.

During recent years there has been some concern about the possibility of the United States losing its supremacy as a cotton-growing country. There is probably little immediate danger; however, it does not completely overshadow its competitors as it once did. During much of the nineteenth century it produced nine-tenths of the world's commercial supply, but in 1938 the United States produced but 43 per cent of the world crop. This declining relative position is explained by increased production in other areas and interference with the free entry of American cotton into foreign markets both by the United States Government in the form of acreage restrictions and artificial price levels and by foreign governments in the form of restrictions on imports and encouragement of domestic and alternative production.

Cotton in the British Empire. Formerly the increase in foreign production was largely a result of British efforts to increase production within the British Empire. Her experience during the American

Figure 142[1]

COST OF PRODUCING COTTON BY REGIONS—AVERAGE, 1923-32

Region	*Yield of cotton lint, lbs per acre*	GROSS COST PER ACRE			*Credit for cotton seed per acre*	*Net cost of cotton per lb*
		Fertilizer and manure	*Labor* *	*Total* †		
MEDIUM STAPLE						
Coastal plain of Georgia and South Carolina	187	$5.45	$17.23	$34.16	$4.67	15.8¢
Piedmont of North and South Carolina	233	6.06	20.31	40.43	5.89	14.8¢
Texas Gulf Coast and Black Waxy	150	.59	13.28	25.61	3.36	14.8¢
Dry areas of western Texas	135	.13	11.14	20.65	2.79	13.2¢
LONG STAPLE						
River bottoms (Miss Valley)	238	1.13	22.30	40.79	6.03	14.6¢
Irrigated areas, Ariz., Calif., etc.	335	.64	27.04	58.34	7.76	15.1¢

* Preparing soil, planting, cultivating, harvesting.
† Total cost includes fertilizer, labor, seed, rent, taxes, etc.

1 Condensed from *The World Cotton Situation, Part II,* "Cotton Production in the United States" (mimeographed), Table 1, p 19. United States Department of Agriculture, Washington, February, 1936. It should be noted that the costs given here are somewhat higher than 1940 costs

Civil War taught Britain that she could not afford to depend on only one source for this vital raw material. There was an added uncertainty arising from the fluctuating production of cotton in the United States, due largely to weather and pests, and the corresponding fluctuation in price. Development of cotton growing within the Empire was also stimulated to provide larger markets for British products in the colonies and mandates, a situation that is essential to British economic prosperity.

For the above reasons, then, the British, as early as 1902, began the promotion of cotton growing in India, along the Indus River, in Africa, especially in Egypt, the Sudan, Uganda, and Nigeria; in Iraq (Mesopotamia), and in parts of South Africa. In spite of all this promotion through bonuses to natives in these regions, free grants of seed and equipment, establishment of experimental farms, and the development of educational systems, there are still gigantic obstacles to development. Such obstacles include high costs of production, the necessity for huge amounts of capital, the backwardness of the natives, and their resistance to changing their primitive methods These obstacles are intensified, moreover, by increased production in areas not under British control, and by the recent downward trend in the price for cotton in the world market.

India. Cotton has been grown in India for thousands of years, and during that period has been the principal textile material of the country. The Indian cotton plant, however, is not the same as that grown in the United States. It is usually much smaller, more drought-resistant, and yields a shorter fiber. The British have introduced American upland varieties with considerable success, but the average Hindu peasant is conservative and slow to change and much of his crop is low both in grade and yield (80 pounds per acre, as against 135 pounds in even the drier parts of the United States). Cotton ordinarily is rotated with millet—a very poor rotation from the point of view of the soil, although it does provide a cash crop (cotton), a food crop (millet), and a fodder crop (millet straw). Since cattle dung is burned as fuel and lint, cotton seed, and oil cake are exported, little of the plant value is returned to the soil.

The bulk of the cotton is grown on the Deccan Plateau to the east of Bombay. Here in the rain shadow of the Western Ghats Mountains is an area of black volcanic soils, rich enough to survive the poor methods of peasant cultivation and spongy enough to hold some moisture during long droughts. Increasing amounts are also being grown in the irrigated alluvial areas along the Indus River and elsewhere in semiarid northwestern India. The British Government has so encouraged the growth of cotton that the yield of India has doubled since 1895, partly through the extension of irrigation and partly through improvements in methods which have increased the yield per acre.

About half of India's cotton production is consumed by her own expanding textile industry. Her exports are almost evenly divided between Great Britain and Japan

Egypt. Egypt is an outstanding producer, both in quality and in high yields per acre (350 pounds). Nine-tenths of the crop is grown on the rich alluvial soil of the Nile Delta, the remainder on both sides of the narrow Nile Valley. Often the crop is rotated with beans or wheat. This practice and the annual increment of mud deposited by the Nile flood suffice to maintain a high degree of fertility in the originally rich alluvial soils. There is, however, an increasing growth of perennial cotton which has changed this condition somewhat.

As the high yields suggest, the land is carefully cultivated. On its level surface ridges about a yard apart are thrown up. Channels for irrigation water are dug at right angles to the ridges. In March the seeds are soaked in water and then planted on the sides of the ridges. The land is watered every two weeks until the end of August when picking commences. An excellent network of canals, roads, and railroads supplements the Nile as means of getting the product to market. Some is shipped to the United States because of its strength and unusually long staple.

China. Cotton has been an important fiber in China since the twelfth century. Local production is about 3,000,000 bales which just about supplies the domestic textile industry in normal times. Before the outbreak of the war with Japan in 1937 China's cotton textile manufacturing industry had grown to the place where it met the needs of the country's markets. Early in the war, many of the most important manufacturing areas fell into Japanese hands and future results are difficult to foresee. Cotton cloth and cotton quilted garments are the ordinary clothes of the Chinese peasant. In the winter quilted garments are a necessity for the scarcity of fuel makes it costly to warm adequately the huts of the peasants.

Chinese cotton is as poor in quality as that of India, but the yield per acre is much higher. This higher yield (170 to 240 pounds per acre) is undoubtedly due to intensive cultivation and heavy fertiliza-

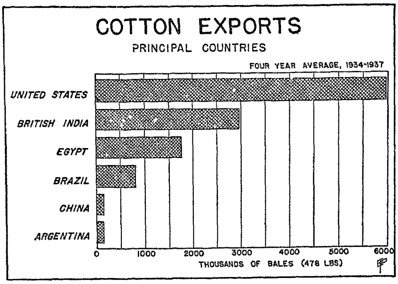


Figure 143 Brazilian production is increasing so rapidly that Brazil will soon take second or third place among the exporters.

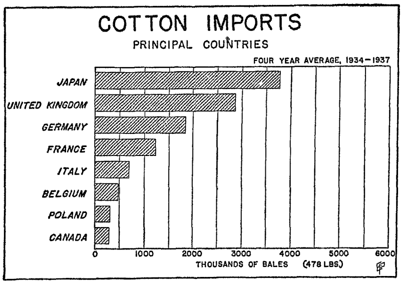


Figure 144. The leadership of Japan is a recent development Note the dependence of Germany on cotton imports.

tion. The type of product and method of cultivation vary greatly. In the north, where cotton is grown very close to its northern limit, early maturing varieties are necessary and one-crop agriculture is practiced in the cotton fields. In the Yangtze-Kiang Valley, the major cotton-producing area, it is planted as a second crop while, or before, a winter cereal crop is harvested. The amount of land in cotton varies considerably with the price, for the land is usually in food crops except when price inducements make it worth while to raise cotton and buy food.

The U.S.S.R. The Soviet Union has within its far-flung borders a large cotton-textile market, a large textile-manufacturing industry, and a constantly expanding cotton-producing area The recent policy of the Soviet Government has been to attain cotton self-sufficiency—a policy which has cost the United States a market in which it was formerly important.

Cotton has long been grown under irrigation in Russian Turkestan and with moisture supplied by rainfall in Transcaucasia. Transportation has been one of the major difficulties in these areas, not only because it increased the cost of cotton in the central Russian industrial areas, but because good cotton land was used for food crops due to the difficulty of importing food. The Soviet Government has not only extended the railroad net (notably by connecting Turkestan with the wheat areas of Siberia), but since 1928 it has encouraged the growth of cotton farther north and consequently nearer the textile mills. Early-maturing varieties have been grown as far north as 47° in a region of European Russia where the summer climate is no warmer than in Iowa.

South America. The American Civil War first called attention to the possibilities of large-scale cotton production in Latin America. When the American supply was cut off, British manufacturers shipped ginning machinery to Argentina, Brazil, and Mexico and distributed free cotton seed among the farmers. For a while a considerable industry developed, but after the war the lower prices and the shortage of agricultural labor led to a decline in the industry. With the beginning of the twentieth century, the South American industry, again encouraged by the British, has grown rapidly and has had its most rapid growth while American producers were reducing their acreage.

Four important centers are responsible for most of the South American product. The numerous small irrigated valleys of the Peruvian Desert produce annually several hundred thousand bales of high-grade, long-staple cotton, similar to that of Egypt. Limited water supply, however, prevents any further Peruvian expansion. Northeastern Brazil, which produces medium-quality cotton, is a second area of importance. In this region production varies greatly from year to year because of uncertain rainfall. Until recently, much of the cotton was harvested from perennial plants which often remained in the ground for five years.

The greatest expansion in recent years has taken place in and around the old coffee belt of Brazil, especially in the states of São Paulo and Minas Geraes, inland from Rio de Janeiro. Recent low prices for coffee have caused a shift to cotton in a region of rich red soils and rolling topography, very similar to the southern part of the American Piedmont. Not only has cotton been planted on former coffee plantations, but much new land farther in the interior has been cleared of forest for this purpose.

The product is similar to American upland in length of staple, and rigid governmental supervision in ginning, baling, and labeling has given this cotton a reputation for quality. A limited labor supply is the principal handicap to continued expansion. However, a mechanization of production and especially the invention of a really successful cotton picker would make this the greatest threat to American cotton supremacy. Since 1931 there has been a fourfold expansion in Brazilian production. About three-fourths of the production is used in domestic mills with England, Germany (before Sept. 1939), Italy, France, and Japan taking most of the remainder.

The Chaco region of northern Argentina has seen a like expansion. Land is cheap and so is the limited supply of Indian labor. Transportation to the market is slow and difficult, and cotton is perhaps the best crop to ship under such conditions. In addition Argentina has a growing textile industry and local cotton is supplying a major part of its raw material. Production since 1914 has jumped from 2000 to 200,000 bales and there is adequate land for a further great increase if more labor were available or if machine cultivation and harvesting could be developed.

QUESTIONS FOR DISCUSSION

1. What countries lead in the production of cotton? Are physical or economic factors most important in making cotton production so important in these countries?
2. What stimulated the British to obtain and assure supplies of cotton from regions other than the United States?
3. In what ways can the Cotton Belt farmer of the South improve his competitive position?

Other Vegetable Fibers

Silk. Silk is not a vegetable fiber, but so dependent on the leaves of the mulberry tree is the silkworm that one can almost refer to it as such. The worm matures and spins around itself a cocoon from which are obtained the long strands of raw silk that are reeled and spun into thread.

The mulberry tree is hardy and can be grown in the temperate and tropical latitudes of many countries. It does best in warm, rather humid areas, although its cool limits are similar to those of the grape. For the best silk production, trees bearing several crops of leaves annually are desired—a condition most prevalent in the warm temperate zone. Although such conditions are available in many lands—including southern Brazil, the American Cotton Belt, South Africa, and eastern Australia—only a few have the all-important human factor: cheap painstaking labor.

In the Orient, both human and physical conditions are favorable. The mulberry is often raised on lands too rugged for other crops, and silk production utilizes labor resources not otherwise marketable. Professor Orchard has well described the labor economics involved in the Japanese industry:

> It is the rearing of the cocoons rather than the reeling of the silk that demands the cheap labor. Practically the entire cocoon output of Japan is produced as a subsidiary occupation of the farmer. Anything that may be received for the cocoons above the cost of the egg sheets and the rent of the mulberry land is considered as profit The labor of the farmer's wife and children in the painstaking care of the worms night and day and the inconvenience of turning over the home to their production are not included in the costs. It is peculiar that this industry, turning out an article of luxury, should be a parasitic industry dependent upon unpaid or underpaid labor from the production of the raw material in Japan to the final weaving of the cloth in American centers where the women and children of miners or steel workers are used in the mills [1]

Japan produces approximately three-fourths of the world's raw silk. China is a poor second with but one-fifth of the total and the remainder is divided between Italy, France, Syria, and a few other scattered districts.

Silk is an expensive fiber and is consumed most largely in countries with high standards of living where the emphasis in women's clothing is on style rather than durability or practicality. As a result, 75 per cent of the world's silk is consumed in the United States, and the only other countries of importance in its consumption are Great Britain, France, Germany, and Italy.

Rayon. In 1884 the first artificial-silk fiber was produced, but for a considerable time the invention was not taken seriously. Since the World War, however, many technical improvements have increased the popularity of artificial silk and it is now a serious rival of the silkworm. It is manufactured by chemical treatment from cellulose, obtained largely from wood pulp or low-grade cotton fiber. At present most *rayon* is inferior to silk in elasticity and strength, although most of the other qualities of silk have been fairly well imitated. An important use of rayon is in mixtures with silk, wool, cotton, and linen where its lack of strength is not a serious difficulty. New weaving methods have also helped improve rayon fabrics, and it is quite probable that most technical handicaps will eventually be overcome.

In 1938, rayon yarns were priced at twenty to fifty

[1] John E Orchard, *Japan's Economic Position*, p. 128. Mc Graw-Hill Book Company, New York, 1930

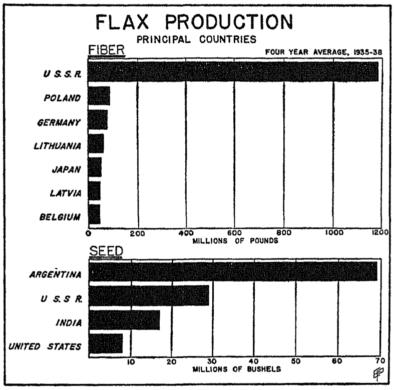


Figure 145.

cents in the United States while basic silk prices stood at approximately $1 70. The competition faced by silk under these price conditions can readily be seen. Only in the manufacture of stockings, where silk's elasticity gives it a tremendous advantage, did that product hold its own.

Japan, faced with the prospect of decline in its silk industry, has become the world's leading rayon manufacturer. Germany, the United States, Italy, and Great Britain followed in the order named in 1938, the last pre-war year. Japan, Germany, and Italy have turned to rayon as a substitute for cotton because it can be manufactured largely from domestic materials.

Flax (Linen and Linseed). The flax plant grows widely throughout the temperate climates, but the labor requirements for *linen fiber* are quite different from those for linseed, although both products are obtained from the same plant. *Linseed,* used for the manufacture of linseed oil, is produced in many sparsely settled grassland areas—including Argentina and the Spring Wheat Belt of the United States—and as a winter rotation crop in India. Most of the fiber is produced in areas in northwestern Europe which have the cheap and plentiful hand labor needed to separate the fiber from the stalk. Russia, the Baltic States, Belgium, and Northern Ireland contribute most of the supply.

Jute, Hemp, and Sisal. These three products, raised in widely separated parts of the world, are important chiefly as raw materials for the manufacture of rope, cordage, and burlap. Like flax, they require a considerable amount of hand labor, although this labor need not be especially skilled. Each, however, tends to be raised in a few areas where the people are accustomed to the work, although there is no apparent environmental reason why the industries should not spread elsewhere.

Jute is practically a monopoly of the lower Ganges-Brahmaputra Valley in northern India. It requires a fertile soil with good drainage, very heavy rainfall throughout a long season, bright sunshine, and a large labor supply. The fiber is manufactured at Calcutta and Dundee, Scotland, into gunny sacks, burlap, and inexpensive rugs.

Russia at one time supplied most of the world's *hemp,* but in relatively recent years Manila hemp, or *abaca,* has supplanted it. This is one of the finest cordage materials grown. Although attempts have been made to grow it elsewhere, they have succeeded only partially, and although some is grown in China, Italy, Russia, and the United States, the Philippines are still the largest and best source of supply. The plant is produced best in a moist climate on hillsides which drain rapidly but are not too dry.

Sisal, or *henequen fiber,* is today almost a monopoly of Mexico and is grown largely in Yucatan. It is the chief export crop of that part of the country and is exported to industrial countries like the United States and the United Kingdom where it is used as cheap cordage.

Other Fibers. The world's fiber resources are by no means fully explored, and there is considerable chance that some new fiber may displace cotton, linen, and wool just as rayon threatens to displace silk at present For example, there is *ramie* (China grass), an Oriental plant fiber which is sometimes substituted for linen. Another newcomer is the fiber of the tropical Ceiba tree, which is used for making Palm Beach cloth.

Some recent developments of entirely nonvegetable fibers are of considerable significance. Glass is now spun into yarn and woven into textiles. It is an excellent insulator and is waterproof and fireproof. *Lanital,* a wool-like fiber, is made of skim milk. Of even greater revolutionary possibilities because it is a coal-tar derivative is *Nylon,* a substitute for silk in the manufacture of stockings where great elasticity and long-wearing qualities are its main assets.

QUESTIONS FOR DISCUSSION

1. What changes in style have upset the demand for textiles? Would it pay fiber producers to try to alter styles?
2. To what extent can textiles be substituted for each other without any serious loss in qualities?

CHAPTER 23

RUBBER—AN INDUSTRY THAT MIGRATED

MANY agricultural products are now of outstanding importance in areas far from their homelands. The physical limits of many plants are wide, but nature has not always distributed plants completely within these limits Plant resources are, of course, first discovered where the plants are growing naturally, and usually they are first exploited near the place of discovery. If a world-wide demand for the product develops, other areas may be found where environmental conditions are equally favorable and where human factors such as labor, government, and nearness to market are more favorable. The discovery of these potentially superior producing areas causes a migration of the industry. Such shifts have been part of the history of many crops, including potatoes, corn, wheat, bananas, sugar, but in none has the shift been so rapid and dramatic as in the production of rubber.

Wild Rubber

Rubber is a solid which is contained in varying degrees in the milk of a large number of plants, most of which grow in the tropics, although there are several nontropical plants of considerable yield. This milk, or *latex,* occurs in tubes in the inner part of the bark and may be released by scarring the bark. The limited extraction of this substance apparently does not injure the tree. When damage occurs, it is probably from the exhaustion of the tree in growing new bark after too much of the old bark has been scarred. Centuries of exploration and experiment have demonstrated that there is one outstanding rubber tree, and that is *Hevea brasiliensis* which grows wild in the Amazon region. Of secondary importance is *Hevea benthamiana* which also grows in this same area.

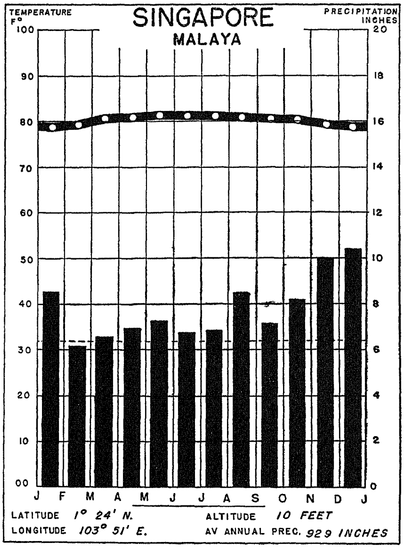


Figure 146. Singapore is in the center of the world's principal rubber-producing area. Note the lack of a dry season.

The Environmental Requirements of Rubber. The rubber plant requires about one hundred inches of rainfall, well distributed throughout the year. If the rain drops below two inches during any month,

ANALYSIS OF PLATE XI: WILD RUBBER AND THE PLANTATION INDUSTRY

In *A,* the "factory" is a crude hut deep in the Amazon forest in which the native coagulates a little of the milk of the rubber tree over a fire of wood and nuts. The large pan at the left contains the milk in which the paddle is dipped to coat the ball with a new layer. *B* shows the factories and dwellings of a well-managed rubber plantation

In *C,* the tapper has to fight his way through the thick underbrush from one isolated tree to another. *D* shows the orderly rows of trees on the plantation. This allows for the collection of large quantities of liquid with a minimum of travel and a maximum of supervision. Keeping the ground under the trees cleared makes for easier transport and cuts down the drain on the soil—thus making tree growth more rapid.

the plant is likely to be injured. Continuous hot, humid weather with no temperatures below 70° F. is also a necessity. Climates meeting both of these requirements of the rubber plant are found only at low altitudes in the moister lands well within the tropics. Most good rubber land is within the wind belt known as the equatorial calms, other rubber lands are found in the wet parts of the moist trade-wind shores (1^t in Fig. 72).

The rubber tree requires moderately good soil. Such soil is usually not found on very steep tropical hillsides where excessive leaching by the heavy rainfall usually removes much of the soil's food supply. On the other hand, the rubber tree will not flourish in swamps or on the water-logged flood plains of many tropical rivers. Gently sloping lands provide a happy compromise between these two extremes of relief and soil.

The Growing Demand for Rubber. Columbus discovered that the Indians in Haiti amused themselves by kicking a ball of a black substance that bounced so energetically that it seemed alive. The substance was not put to any practical use in Europe until some time after 1800, when an English chemist discovered that it would erase pencil marks. It then came into general use as a "rubber"—hence the name. Some time later a Scotch manufacturer discovered that it could be used to waterproof cloth. In 1839, Charles Goodyear of New Haven, Connecticut, discovered the hot-vulcanization process and, at about the same time, an Englishman had developed a cold-vulcanization method. By mixing rubber with sulphur it was found that it became stronger, more elastic, less affected by temperature changes and insoluble in the more common solvents. By varying the sulphur content and putting in other substances, a wide variety of qualities could be given to the finished product.

By 1910, rubber was a commodity very much in demand. People in all walks of life wore rubber foot coverings in rainy weather and the farmer wore rubber boots much of the time. Rubberized clothing for protection from rain was very popular. Tremendous quantities of rubber were consumed by the bicycle-tire industry and by the growing demand for automobile tires. At this time rubber was expensive. During 1910 it sold for as high as three dollars a pound. It was not surprising, therefore, that junkmen paid good prices for cast-off rubbers, rubber boots, hot-water bottles, old bicycle tires, and, in fact, anything that had any reclaimable rubber in it.

Wild Rubber Gathering and Expanding Markets. The increasing use of rubber throughout the world was taxing the regions of production to their utmost during the first decade of the twentieth century. Prices were high, and a rubber boom developed that resembled in many ways the boom in California during the gold rush. The center of production—and of the boom—was the Amazon Valley of South America. Here the two principal trees which have been found to yield the best commercial grades of rubber grow wild in relative profusion. No other region yielded any considerable quantities of rubber which was comparable in quality.

The Amazon rubber industry was based almost entirely on the exploitation of wild rubber trees which were scattered at intervals of fifty to five hundred feet throughout the forest. The owner of a stretch of jungle would hire Indians to cut paths from tree to tree and then contract out the gathering and curing of the latex, each contractor having a hut in the center of his small patch of jungle.

The principal problem was labor. The Amazon Valley is very sparsely inhabited, and the natives present are generally unsatisfactory as a labor supply. They are in a low stage of development and are almost constantly ill. Fortunately for the rubber industry it was possible to import workers from the coastal state of Ceará. Shortly after 1900 this region had developed such a large population that the recurring years of drought common to the state sent thousands of its natives abroad looking for work. They were much superior to the Amazon natives in ability and stamina and became the principal labor supply.

The procedure of actual harvest of the rubber was simple and unvarying. The worker went around to each of his trees at sunrise, scarred a section of the bark with a hook, and hung a pail at the bottom of the scarred section. Later in the day he would make another round and collect the milk. When a sufficient quantity had been gathered he would coagulate the solids in the latex by putting in small quantities of acetic or formic acid and then commence the process of drying. This consisted of dipping a wooden paddle in the coagulated mass and then turning it slowly in the smoke of a wood or nut fire until it was dried. This was continued, layer after layer, until a ball of rubber resulted. The limits of this ball in weight and size were set by the ability of one man to carry and the size of the canoes used as transportation.

This rubber-gathering system resulted in consider-

able variations in the quality of the products, for there was little control over the methods of thousands of native contractors and rubber collectors. Often as much as ten or fifteen per cent of sticks and stones would be mixed with the rubber. The system was also very expensive, since all supplies and labor had to be freighted great distances into the interior and the final product handled several times before it reached Pará at the mouth of the Amazon.

Pará and Manáos. Two Brazilian cities were the commercial centers of this empire of rubber, and their names were synonymous with the rubber trade. One was Pará, the "New Orleans of the Amazon Valley," situated on a side channel in the delta. Here rubber was received, traded in, and loaded for overseas shipment. Here were imported the millions of dollars worth of supplies needed to equip the rubber workers every year, and through this port passed the thousands of coast Indians from Ceará who went to work in the rubber country every year at the close of the rainy season.

To meet the demands of the growing business in rubber, a modern city had been carved from the surrounding jungle. There grew up comfortable hotels, large banks, a power plant, paved streets, great warehouses, and modern docks. The city was so closely identified with the trade that it gave its name to the highest grade of commercial rubber—"hard, fine Pará."

Manáos, one thousand miles upstream, might be called "the St. Louis of the Amazon." At this point the principal tributary from the north, the Rio Negro, brought in the rubber cargoes of a wide region. This was also the head of large steamer navigation, so it became the interior concentration point for the rubber country. The city was so prosperous that, in the midst of a steaming jungle, there were paved streets, beautiful buildings, and even streetcars. A million-dollar opera house was started and the Manáoans boasted they would soon be able to hear the best European talent.

The Amazon country had an apparent monopoly on rubber, and the world was finding new uses for it every day. In spite of high costs, the industry flourished. The Brazilian Government and the governments of the states reaped huge sums in taxes. Palaces were built by the rubber kings in Manáos and Pará, and the Amazon country rode the crest of the tide of prosperity.

And then the bottom dropped out of the boom! Prices dropped, production of wild rubber declined, the opera house at Manáos stood unfinished, and grass grew between the rusting rails of its streetcar line. Another rubber region had come into being with lower costs, better labor, more control over its product, and cheaper transportation.

A New Rubber Area. As early as 1834, an English rubber manufacturer had suggested that rubber plantations be developed in some of the British colonies in the East. There was, however, no rubber-yielding tree in the East which was as good as *Hevea brasiliensis*, so there was little development.

In 1873, the interest in the possibility of producing rubber in the East had grown so great that the director of the Royal Botanical Gardens at Kew, England, became interested. He had seeds of *Hevea brasiliensis* sent to him and, after several trials, got them to germinate in hothouses and shipped the shoots to Ceylon where they were successfully grown. In the next thirty years, more and more trees were set out in various British colonies, and, in 1910, eleven thousand tons of rubber were exported from the East Indies.

From that year, the center of rubber production shifted from the jungles of the Amazon to the plantations of the East. There is still some wild-rubber production, but it is of relatively small significance, for the wild industry needs high prices to cover its high costs and it cannot compete with plantation production.

QUESTIONS FOR DISCUSSION

1. How do the rubber-producing areas differ from the rubber-consuming areas?
2. How appropriate are the names given to Pará, "the New Orleans of the Amazon," and to Manáos, "the St Louis of the Amazon"?
3. What are some important reasons for shifts in the principal producing areas of plant products?

Plantation Rubber

The Advantages of Plantation Production. What advantages does the East have besides physical conditions suited to the rubber plant? It is fortunate in having the best supply of tropical labor in the world. Perhaps because of race, probably because of the necessities imposed by a crowded population, the Indian and the East Indian have been engaged in field agriculture for centuries and have developed the habit of unremitting labor. In addition they have already had experience on plantations in the sugar, coffee, tea, and spice industries and are accustomed to work under competent white supervision. Their health is better, partly because of the white man's sanitation and partly because of the temperance in

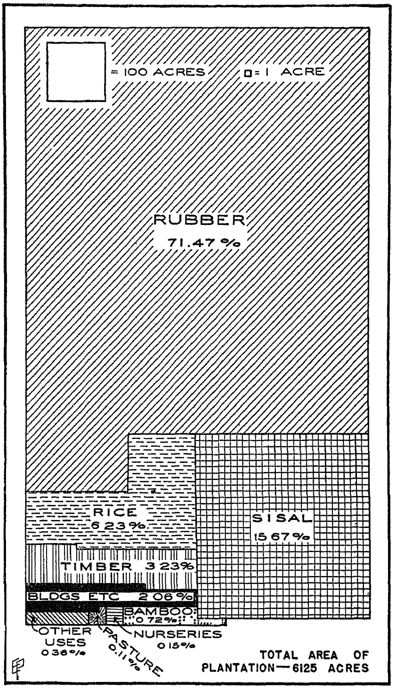


Figure 147 Diagram of land use on a typical East Indian rubber plantation. Although rubber, like most commercial tropical crops, is grown on a one-crop basis, a small part of the land is devoted to catch crops and food supplies. The sisal is raised on soils not suited for rubber.

many things imposed by their religions. The superiority of East Indian laborers may be gathered from the fact that the British have transported them to Trinidad and British Guiana to labor on the plantations in a region already swarming with American Indians and Negroes.

Most of the plantations of the East are on relatively small islands, or near the coast on the mainland, so that transportation is not difficult or expensive. Then, too, the region around Singapore and Ceylon was already a well-developed center of trade in other products, and trade and transport facilities were already established. Furthermore, the British investors were much more willing to invest capital in regions under European political control, where they might expect more sympathetic treatment than was likely from the relatively unstable governments of tropical Latin America.

Production in the East is much more orderly, and a controlled product is the result. Here, instead of balls of rubber of varying weights which might contain anything from twigs and leaves to stones mixed with the rubber, much of the product is delivered in the form of sheets. The trees are planted close together so there is a large production in a small area. This allows for factory methods. The latex is gathered under uniform conditions and coagulated in large vats. The rubber is then pressed out into sheets and dried. The thicker sheets have to be dried by artificial heat but the thin ones, called *crepe,* are hung in sheds where the air dries them.

The Modern Rubber Plantation. An East Indian rubber plantation provides an excellent example of the highly organized nature of a large tropical plantation. It usually consists of several thousand acres which include rubber lands, forest lands, rice fields, power plants, tram lines, rubber mills, warehouses, and native villages. The staff consists of a European manager, European assistants (including probably a chemist and engineer), an office force of half-castes, and numerous native foremen with hundreds of native laborers under their supervision.

A considerable capital investment is necessary to start a rubber plantation, for there will be few marketable products until five or six years after the first trees are planted. Laying out a plantation is no easy job, for the forests must be removed, drainage ditches dug, roads constructed, and buildings erected. As soon as possible the trees are planted—usually in rows twenty-four feet apart with twelve feet between the trees in each row. The trees are planted more closely than they will stand in a mature plantation, so that the poorer trees can be eliminated. Between the rows, coffee, which matures in thirty months, or some other crop may be planted. Such catch crops yield some income from the land while the rubber trees are maturing. Meanwhile, the rapidly growing weeds must be kept down between the trees, drainage must be maintained, and soil erosion must be prevented. The top soil is lightly cultivated with a hoe, and great care is taken to protect the roots which spread out very near the surface.

When the trees are six inches in diameter, tapping begins. The native tappers are specially trained in "tapping schools," and are paid twenty cents a day while learning. Expert tappers are paid according

to their harvest. Their work begins at daybreak and continues until noon. A small sample of the latex each tapper brings in is analyzed. Payment is based on quality as well as quantity, and an expert earns forty to fifty cents a day.

After the latex is collected, it is prepared for market by one of several processes These usually involve chemical treatment and smoking. The plantation product is marketed in thin sheets and is very high in quality. Recently a good grade of rubber has been manufactured from the latex without the use of chemicals. This grade is known as sprayed rubber.

The Time Factor and Tree Crops. In most industries, an increasing demand (usually accompanied by increasing prices) stimulates producers and, within a short time, results in an increasing supply. Trees, however, cannot be brought to maturity overnight or in one season, hence an increasing demand for tree crops usually results in an increasing supply only after a lag of several years. For rubber, the lag is at least five years, hence an increasing demand for rubber during the World War brought a great flood of rubber on the market five and six years after.

To a certain extent, it is possible for the rubber industry to respond immediately to an increased demand. Wild and semiwild trees are brought into production when prices rise. This is especially true of the rubber "gardens" of the natives in the Dutch East Indies. These are usually small units which are not tapped in periods of low prices, since the natives live from their general food crops. A small rise in prices, however, results in a rapid increase of production from these sources as the native owner puts his family to harvesting rubber. The large plantation may overtap in periods of low prices in an attempt to produce enough extra units from the more efficient areas to counteract the lower price per unit.

QUESTIONS FOR DISCUSSION

1. What are the advantages of obtaining tropical products from plantations as compared with gathering these products from the forest?
2. Why haven't rubber plantations become more important in tropical America?
3. In what industries other than rubber does an increased supply lag considerably behind an increased demand?

Recent International Competition in Rubber

From the time of the introduction of plantation rubber, prices declined steadily until the World War. Improved management kept profits high by using better trees, better methods of collecting, and better methods of manufacture. After the war, the depression of 1921 brought rubber prices to such a low figure that few plantations were profitable. New plantations, planted during the preceding era of high prices, had just reached maturity, and even the growing automobile industry was outstripped by the flood of rubber. In 1922 the British growers forced the British Government to impose export restrictions. This reduced the amount of tapping, attempted to keep the supply proportionate to the demand, and raised the price from ten cents a pound in 1921 to more than one dollar in 1926. The result of this might well have been predicted. The United States, which normally consumes more than half of the world's rubber, began looking for new sources of supply. Edison conducted his investigation of the rubber yield of various American plants and had some success with the common goldenrod. The American tire companies began to establish plantations in non-British countries. Firestone opened up a new area in Liberia, Ford established a plantation on the Amazon, and experiments were conducted in the Philippines.

At the same time, the British awoke to the fact that they not only did not hold a monopoly of rubber-producing conditions in the world; they did not have a monopoly of rubber-producing conditions in the East. The Dutch had been slow to go into rubber production, but many of their Eastern colonies were suited to it, and the high prices arising from the British restrictions were a real inducement. At about the end of the World War, the Dutch taught the natives how to plant rubber seeds in abandoned rice fields. In a few years, a jungle of rubber trees was a part of many native farms. When prices rose these trees were ready to be tapped and crude rubber farming became a menacing competitor of scientific plantation agriculture.

Java and Madura and Dutch Borneo became so important that they were producing almost as much as the British colonial islands. The restrictions could not continue under those conditions, and they were removed in 1928. As a result, rubber sold for six cents a pound in 1932.

In 1934, British and Dutch producers, after considerable difficulty, managed to persuade the other producing areas (Indo-China and Siam) to agree to a quota system of production, these quotas to increase gradually. To date the plan has been moderately successful in maintaining prices, but certain difficulties are likely to arise. Brazil, Liberia, and the

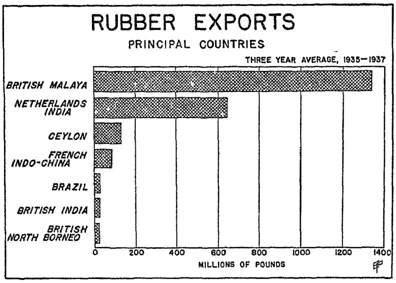


Figure 148 The concentration caused by cheap East Indian labor is striking.

Philippines are not included and may increase their production. Then there are the many native producers in the East Indies who have a few acres of trees and whose production is difficult to control.

Another limitation is the availability of substitutes. Scrap rubber plays an important part in the present American rubber industry. Synthetic rubber may further subtract from the American demand for plantation rubber. In 1931, the Du Pont interests announced that they had developed a synthetic rubber (Duprene) which, although expensive, was valuable as a container for certain acids and oils which tended to dissolve natural rubber. Further experiments have shown that the cost of production of this synthetic rubber can be reduced A decided rise in the price of plantation rubber might lead to a widespread adoption of synthetic and reclaimed rubber.

Rubber-like Gums. *Balata* and *gutta-percha* are two rubber-like products which are made from the latex of wild tropical trees. Balata is obtained from the forests of northeastern South America. It is more resistant to water than rubber and is used as a rubber substitute in the manufacture of waterproof belting, cables, and similar products. Gutta-percha is like rubber, but does not stretch as much. It is used for a variety of products, including containers for hydrofluoric acid and covers for golf balls.

Chicle and several related gums are the raw materials for the chewing-gum industry. Chicle is the latex of a tree found in Central America. Other trees found in South America and the East Indies provide chicle substitutes.

International Trade in Rubber. The rubber-producing nations closely coincide with the rubber-exporting nations, for little rubber is consumed by the nonindustrialized tropical-forest areas. Most of the present world production comes from the East Indies.

The rubber-importing nations are the industrialized countries of the world. Except for the United Kingdom and the Netherlands, these countries are almost completely dependent for this essential raw material upon the colonial possessions of other powers.

London is the principal rubber market, for formerly most of the world's rubber was collected in London warehouses before it was transshipped to the areas of ultimate consumption. Most rubber is now shipped directly to the United States and other consuming countries, but financial arrangements are often made through London. In Malaya, there are also important marketing centers at Peñang and Singapore.

QUESTIONS FOR DISCUSSION

1. If the price of rubber were again increased by foreign control, where might American companies obtain a substitute supply? What difficulties might retard such substitutions?
2. Compare the raw-rubber and raw-cotton industries.

CHAPTER 24

SUGAR AND ITS HUNDRED-YEAR INTERZONAL WAR

For more than a hundred years the sugar industry has been engaged in an economic war. Not one gun has been fired, but the amount of human agony has been as great as that caused by many wars important in military history. The battles are of interest because the opposing forces represent two major climatic zones. The sugar-cane planters of the tropics were the defenders, the aggressor was the sugar-beet industry of the cool temperate zone. The fight has been political as well as economic, for it has involved several of the world's national governments. The weapons used have been science and legislation; the destructive results have been unemployment, personal and governmental bankruptcy, economic uncertainty, destroyed markets, and, indirectly, revolution Similar wars have occurred over other products, but in no other has the fight been so widespread and so prolonged. The story of the sugar struggle has broad significance, for it is an excellent example of the advantages, the dangers, and the complexities of governmental interference in business.

Sugar is found to some extent in most plant saps, but the high cost of extraction eliminates most of these as sources of commercial supply. In Europe, honey was the common sweetening substance until European countries obtained colonies with a sugar-cane climate. In the temperate zone, maple sap, beets, carrots, parsnips, corn, and sorghum have provided sugar, while in the tropics sugar is found in considerable concentration in the sugar canes, the palms, and in many tropical fruits.

The Sugar Cane

Environmental Requirements. This plant, which roughly resembles earless Indian corn in appearance, is a native of India.[1] It is well suited to the continuously warm, alternating wet and dry monsoon climate. Rainy weather produces a rapid growth of the cane, while hot, relatively dry weather rapidly increases the percentage of sugar in the cane. For these reasons, the cane is usually planted during the rainy period and harvested during the drier period (not always the following drier period, however). There are so many varieties of cane, which have been evolved partly by nature and partly with man's assistance, that it is hard to generalize about the conditions of cane production. Some canes mature in nine months, others do best with a two-year growing season; some types of cane (plant canes) are replanted after each harvest, in others (called "ratoons") the cane plants are allowed to grow up again from the old roots. On the whole, canes are most profitably grown in tropical lands with about sixty to eighty inches of rainfall. However, because of tariff protection and other aid, sugar cane is found within the temperate zones as far as 32° north or south latitude.

A deep, moist, loamy soil with an adequate supply of nitrogen is best for the canes. These conditions are found in a variety of tropical and subtropical soils including limestone, alluvial, and volcanic soils. The cane uses so much nitrogen and other plant nutrients that fertilization soon becomes necessary. Cattle manure, guano, chemicals, molasses, and cane trash are commonly used.

Labor. Sugar cane requires labor at irregular intervals throughout the long growing season, but the labor need not be especially intelligent or careful. The soil is first prepared by plowing (and, where necessary, by fertilization), buds from the cane stalks (called "cuttings" or "sets") are then placed in rows (sometimes in holes) in the loosened soil and watered. The cuttings germinate and form the root system of a new clump of canes. After this, little need be done until harvest time except infrequent weeding and possibly additional fertilization. At harvest time a large force of laborers is hired to cut down the cane stalks with machetes and load them into oxcarts or onto narrow-gauge railways which carry the cane to the sugar factory. Since the cane spoils easily, it must be used soon after cutting, and the raw sugar is usu-

[1] The word *sugar* and similar words in other European languages can be readily traced back to the Sanskrit term, *sharkara* Saccharin, a sugar substitute obtained from coal-tar, derived its name from the Greek form, *sakchar*.

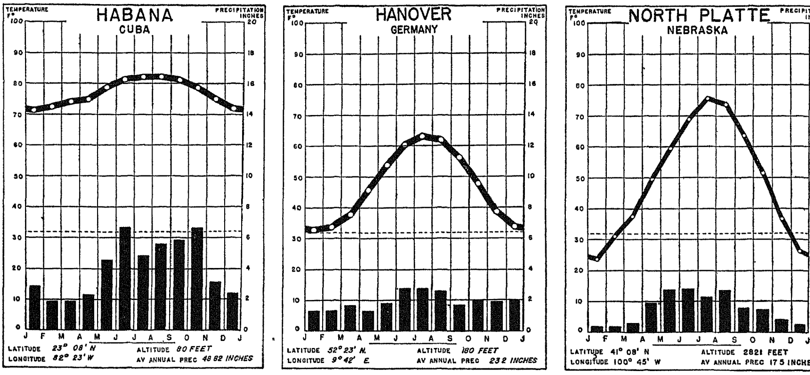


Figure 149. Three stations selected to represent the climates in which sugar is produced

ally made from the cane within a few miles of the fields. The sugar factory (called a *central* in Spanish-speaking countries) usually has one or more trained chemists and engineers on its staff, but except for these and the manager, its employees are often poorly paid, low-grade labor.

Manufacture. The raw-sugar factory produces a light yellowish-brown product which is rarely seen in this unrefined state by the temperate-zone consumer. Important by-products are molasses (used in cooking, for cattle feed, and in making fertilizers), rum (distilled from fermented molasses), and bagasse (or megasse), the fiber left after the juice is squeezed from the cane. Bagasse is used as fuel in the sugar factories, as a mulch, and, recently, to make composition board such as "Celotex." The proportions of sugar, molasses, and rum produced are affected by the market price of each, as is illustrated by the present tendency of sugar producers to produce more rum and molasses while the price of sugar remains low.

Early History of Sugar Cane. In India, sugar has been an important article of diet for thousands of years. In Europe, it has been slightly known since the time of Alexander the Great It became better known when the Arabs invaded Spain and planted some cane there. The Crusades made it even more familiar to the middle and upper classes of western Europe. However, just before the Period of Discovery, sugar was still a great luxury and the trade in it was controlled largely by the Venetian merchants.

With the discovery of tropical America, sugar-cane production increased rapidly. In 1494 the Spanish introduced the cane into Santo Domingo, and early in the next century plantations were established along many of the tropical shores of America. Native Indian labor was used at first, but the proud Indian made a poor slave and was soon supplanted by the more pliable African Negro. Sugar was probably the greatest influence in encouraging the development of the slave trade, which was responsible for the predominantly Negroid population of Caribbean America.

During the sixteenth, seventeenth, and eighteenth centuries, sugar was a commodity of first-rate importance to the ruling classes. The ladies demanded sugar for candy, tea, and coffee, while rum was considered equally essential among the men; molasses as syrup and in cooking was popular with both sexes. European statesmen often overestimated the value of their tropical colonies because of their desire for sugar products. In 1763, at the close of the French and Indian War, Benjamin Franklin had difficulty in convincing the British statesmen that they should take Canada from the French instead of the small West Indian island of Guadeloupe.

The Sugar Beet

The Rise of the Sugar Beet. The sugar-cane planters apparently had complete control of the market in 1800 and foresaw no danger of losing their monopoly. In 1747 a German chemist had discovered that a close relative of the ordinary beet contained a considerable amount of sugar. This discovery was almost forgotten until rising sugar prices on the con-

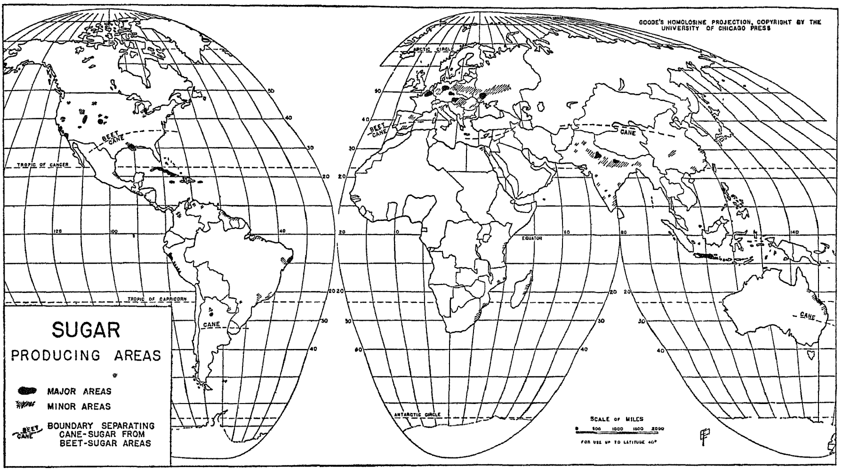


Figure 150. Tariffs and subsidies have spread the sugar industry throughout the middle and low latitudes

tinent resulted from the blockades and restrictions of the Napoleonic Wars. These higher prices made profitable the establishment of a beet-sugar factory in 1801. Napoleon decided to encourage the expansion of the new industry because he recognized that sugar was a valuable food to refresh an exhausted army. In 1806, the French Government offered a bounty for beet-sugar production, and by the end of the Napoleonic Wars the practicability of beet sugar had been demonstrated.

The European beet-sugar industry was nearly destroyed by the renewed competition of cane after peace was reestablished. One factory kept going, however, and chemists and agriculturists continued experimenting in order to improve the sugar beet. These experiments were carried on most intensively in those countries which lacked tropical colonies, and were especially successful in Germany. By seed selection and improved methods of sugar extraction, science turned the beet into a strong competitor of the cane. In 1836, eighteen pounds of beets were required to make one pound of sugar, while today less than seven pounds of beets are equally productive.

Environmental Requirements. The ordinary beet will grow from the edge of the tropics nearly to the polar regions, but beets with a high sugar content flourish only in a climate roughly similar to that of Germany. The crop needs a growing season of about five months with long, moderately warm, sunny days during a large part of the season. Usually a climate warm enough for the best growth of corn is too warm for the sugar beet, thus corn and sugar beets rarely compete for land. For the same reason, sugar cane and sugar beets are almost never found close together and, with a few exceptions, are not found within the same political unit. The rainfall should be moderate and well distributed, although where this condition is lacking, irrigation will give equally good, or better, results.

The sugar beet requires a very good soil, but the crop is so valuable per acre that it often pays to apply considerable fertilizer to meet this requirement. The soil should be a fertile, sandy loam, rich in lime, and carefully prepared by deep plowing and harrowing.

Labor. The beet requires a large and relatively cheap labor supply. Women and children are often employed—since the work requires little muscle but close attention. The beet field must be kept carefully weeded throughout the growing season. In the fall the beets are plowed out of the ground, and their tops are cut off and used for cattle feed. The roots are then piled up and covered with straw or earth until the factory is ready for them. The labor required for

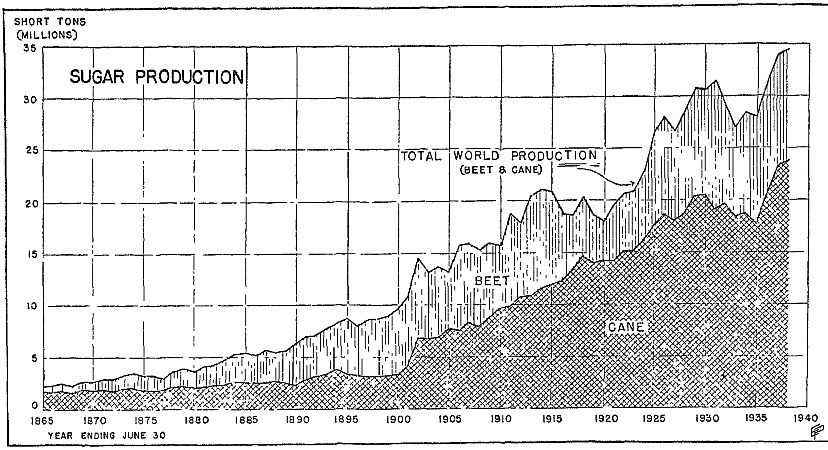


Figure 151.

an acre of beets is six times as much as is necessary for an acre of corn, but this labor can be performed for the most part by workers not strong enough to do heavy farm work.

The Advantages of Beet Production. Because the sugar-beet industry benefits many groups of people in Central Europe, statesmen have been successful in getting popular support for the industry, although it has increased European sugar prices. The industry provided continental powers such as Austria-Hungary, Germany, France, and Russia with a source of sugar which could not be blockaded by a strong naval power. Furthermore, the intensive, careful cultivation and fertilization which was an integral part of the industry improved the soil and increased the yield of succeeding crops. For this reason, the sugar beet was an important addition to the usual crops in crop rotation. Weeding provided work for women and children and thus added to the total family income of many peasants and laborers. The beet provided a good cash crop for those areas where corn could not be easily grown; it also provided additional fodder and thus increased the cattle-carrying power of the land. The cattle, in turn, provided manure which further improved the fertility of the soil. This was an important factor in the relatively poor, gray-brown podzolic soils of northwestern and north-central Europe. The increased number of cattle also provided local milk and meat for the industrial population.

QUESTIONS FOR DISCUSSION

1. How does the sugar beet compare with the sugar cane as to soil, climatic, and labor requirements?
2. How does the sugar beet fit into the economic life of northwestern Europe?
3. Why is there almost no beet production in the Southern Hemisphere?

The Hundred-year Economic War

About 1840, several central-European powers encouraged the beet industry by giving it tariff protection. During the middle of the nineteenth century, beet sugar made steady progress in conquering the markets of central Europe. The cane planters were not greatly disturbed by the growth of this competitor as the increasing demand for sugar elsewhere made up for lost European markets. Furthermore, the tropical planters were barely able to maintain their production, for, during the middle of the century, slavery was being abolished throughout the European colonies. During this period the cane planters generally used old methods of farming and sugar manufacture and neglected scientific experimentation. Meanwhile, the beet industry was increasing in both size and efficiency and was supplying a constantly larger percentage of the world's growing demand for sugar.

Tariffs. By 1880, a group of strong central governments had arisen in Europe and had, in many cases, replaced large numbers of petty states. These new

governments followed a nationalistic economic policy which included the establishment of protective-tariff walls. The tariffs on sugar were so high that home producers could make a considerable profit by selling in the home market at a price just below that for which cane sugar could be imported, duty paid. Soon, production in the beet industry expanded sufficiently to supply the sugar needs of the beet-producing countries.

Bounties. By this time the various governments (especially Germany, France, and Austria-Hungary) realized, fully, the advantages of the sugar beet in improving agricultural conditions. To encourage more widespread growth of the beet, these governments offered to pay a bounty on all sugar exported. The amount of this bounty varied, but was set to enable the beet sugar to compete with cane sugar in free-trade markets.

The Crisis in Cane Sugar. England was the principal market where this bounty-fed sugar was dumped. At first, the English were pleased to be able to buy their sugar so cheaply, but loud protests that they were unable to compete with this bounty-fed sugar were soon received from British Guiana and the British West Indies. A Royal Commission was appointed to investigate the crisis.[1]

The Commission's report painted such a dark picture of conditions and prospects in the West Indies that the home government took action by threatening tariffs on bounty-fed sugar. Finally, the Brussels Sugar Conference of 1902 drew up an agreement by which the principal European powers agreed to ban the importation of bounty-fed sugar and to reduce their tariffs to not more than one-half cent a pound.

This crisis served to awaken the cane planters to the need of improving their technique. New varieties of cane were evolved, and in this way the sugar production per acre was more than doubled (often much more, as in Java where the yield rose from 1842 pounds per acre to 10,030 pounds). Efficient modern factories which extracted 90 to 95 per cent of the sugar content replaced the small sugar mills with an efficiency of only 50 to 75 per cent. Other changes also contributed to the strength of the cane countries. The United States introduced a protective tariff on sugar which benefited the American-owned, or financed, cane-producing areas of Louisiana, Hawaii, Puerto Rico, the Philippines, and Cuba. American capital flowed into the areas surrendered by Spain in 1898 and many improved methods were introduced by the large American corporations. The American tariff, however, not only helped the cane areas, but also caused the foundation of an important beet industry in the New World. Japan acquired Formosa (Taiwan) from China in 1895 and set up a cane industry adequate to supply her needs. At about the same time, many marginal cane countries (such as Australia, Spain, Brazil, and Argentina) decided to become self-sufficient in sugar by establishing high tariffs.

The World War. During the World War the cane industry boomed. The beet-sugar supplies from Germany and Austria-Hungary were kept out of the market by the British blockade, while most of the beet fields belonging to the Allied Powers were in or near

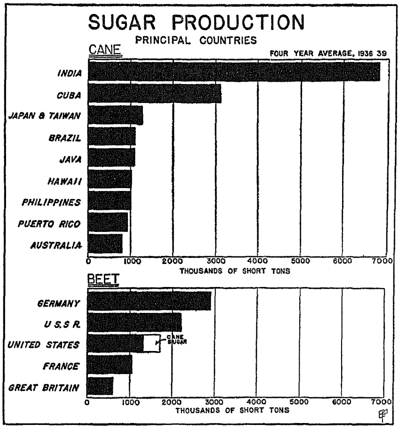


Figure 152.

[1] From the Commission's Report (Parliamentary Papers, 1898, Vol L) the following figures are extracted (reduced to cents)

Average price of sugar per pound at London	English Sugar Imports: Cane sugar from British colonies (thousands of tons)	English Sugar Imports: Beet sugar (thousands of tons)
1882 . ... 6 cents	1882 278	398
1885 .... 3.8 cents	1885 197	562
1890 .... 3 5 cents	1890 117	987
1895 .... 2 1 cents	1895 145	1,169

Cost of sugar delivered in Hamburg, about 2 cents a pound; bounty paid by Germany on sugar exported, 35 cents per pound, protective tariff on sugar imported into Germany, 4 3 cents per pound, internal duty on German sugar sold in Germany, 2.2 cents per pound

the war zone. As a result of this abnormal situation, the demand for cane sugar suddenly increased Although Cuba nearly doubled its production during the war period and many other cane areas underwent considerable expansion, the Allied Powers found it necessary to ration the sugar supply After the war, these restrictions on consumption were removed, and for a while the demand far exceeded the supply. In 1920 the beet-sugar industry of Europe again became an important producer and the price of sugar, which had risen to twenty-three cents per pound in 1920, dropped abruptly to five cents.

Postwar Depression. The postwar depression in the sugar industry has been a period of increasing tariffs and of innumerable makeshifts by which the governments and the planters have attempted to keep the sugar plantations out of the bankruptcy court. In Australia the government has practically taken over the Queensland cane industry: prices are strictly regulated and the tariff has been carried to its logical conclusion by completely forbidding the importation of sugar. By such severe methods, Australia has kept its industry going, although its cost of production is two or three times that of Cuba or Java. Other countries have taken like measures, although to a smaller degree. Java, which seems to have close to optimum conditions for raising sugar, has been almost the only country which has survived the crisis without great governmental assistance. In Europe, countries such as Germany tried to increase their sugar exports in order to pay reparations and other debts. In 1931, the major sugar-producing countries found the market suffering from oversupply and tried to remedy matters by the Chadbourne Plan which restricted exports. This plan was only partially successful, largely because it only affected that tenth of the world's sugar production which enters international trade without the benefit of subsidies or tariff preference. A more comprehensive five-year plan was signed by twenty-one nations in 1937. Although the agreement has shown some of the weaknesses of the Chadbourne Plan, it has at least prevented further declines in sugar prices.

QUESTIONS FOR DISCUSSION

1. If the price of sugar were two cents per pound in England in 1897, using the figures on page 203, what was the probable price of sugar in Germany? (Disregard freight charges.)
2. Was the value of the English sugar import in 1895 greater than in 1882? Make a similar calculation for beet and cane sugar separately.
3. In which parts of the world did consumers benefit by the sugar war? Which areas paid the costs of the war?

The World's Leading Sugar Producers

Political interference has tended to distribute the production of sugar more widely than natural conditions alone would justify. If all political interference were removed, Cuba and Java alone might easily produce most of the world's sugar supply at a very low cost. But governmental policy has given these producers with optimum conditions a handicap, and the sugar industry has tended to spread within the physical limits of beet and cane production. Manifestly, many of these producers are in the business only because their high costs of production are subsidized by the government directly through bounties and subsidies or indirectly through high tariffs.

The United States. The United States is one of the few countries in which both the beet and the cane are produced in considerable quantities. Both industries are conducted at a disadvantage: the Louisiana cane industry is at the northern limit of commercial cane production, while the beet industry suffers from relatively expensive labor. The United States Tariff Commission in 1926 found the costs of sugar production in American possessions compared unfavorably with Cuba as follows·

AVERAGE COST PER POUND, 1920-21–1922-23

	Cuba	3.5476 cents
United States sugar-producing areas	Louisiana	5 5420 cents
	Beet Regions	5 9626 cents
	Puerto Rico	5 2260 cents
	Hawaii	4 9743 cents

It must be remembered that these figures do not include freight rates to the market, nor do they represent extreme cases, as in 1920-21, when the difference between Louisianan and Cuban costs was nearly four cents. Nevertheless, they show clearly why the American sugar producers work together to maintain tariff protection.

The sugar-beet industry in continental United States is expanding, while the Louisianan cane industry has, for some time, barely held its own. The growth of the former may be attributed to high prices (due to tariffs), the use of cheap labor (often the families of factory workers), and, most important, the fact that many western areas can produce no other crop which will stand the high cost of transportation to distant markets.

Sugar beets fit into a crop-rotation system such as the following (used in irrigated sections near Billings, Montana):

1. Alfalfa or sweet clover (winter crops)
2. Beans, corn, small grains, or potatoes on spring-plowed alfalfa or clover land, then alfalfa
3. Beets on spring plowing, manure being applied the previous fall or winter
4. Alfalfa or clover.

This rotation produces excellent fodder for the cattle industry which is so important in the West. Alfalfa hay forms the basis for most rations, while beet tops and pulp, corn, and small grains are good for either cattle or sheep feed. The careful cultivation of the fields in sugar beets cleans weeds and other undesirable elements from the soil.

Also within the American tariff barrier are Puerto Rico, Hawaii, and the Philippines,[1] all of which have conditions which approach the optimum for cane. The industries in these countries are, because of this tariff advantage, relatively prosperous in spite of the almost universal sugar depression in other producing areas.

Cuba. Sugar might well be called the lifeblood of the Cuban economy, for roughly nine-tenths of Cuba's average yearly exports consist of sugar or sugar products Since 1900, Cuba has been the world's largest sugar exporter and would have an even larger industry were it not for the protective tariff of the United States, Cuba's principal customer. In fact, the Cuban sugar situation is largely due to American politics. The American sugar tariff is largely a compromise between the arguments and political power of two groups. The first, including the sugar-beet farmers, the Louisiana cane planters, and the large sugar corporations of Hawaii and Puerto Rico, favors a high sugar tariff. Opposed, are the American investors in Cuban enterprises and those exporters who sell American goods to Cuba. In the past, a 20 per cent preference granted to Cuba has given Cuba almost a monopoly on the sugar imports of the United States. Recent tariff agreements have reduced the American tariff on Cuban sugar from two cents to nine-tenths of a cent per pound. Cuba is allowed to export to the United States a quota of 1,902,000 short tons annually under this agreement.

Cuba's excellent position has made her cane fields accessible to the neighboring American market; and her site, so excellent for large-scale, one-crop farming, has allowed her to take full advantage of her position. Unlike most of the West Indies, Cuba is largely level. This reduces transportation costs and permits large farms and the use of machinery. The large size of the plains areas permits the erection in the midst of extensive cane acreages of large and efficient sugar factories (centrals), many of which represent a capital investment of more than $1,000,000. These efficient factories are largely the result of a great influx of American capital following the Spanish-American War.

The climate is of the tropical-savanna type with a relatively dry period in the spring, the cane harvest season. The sugar soils are largely decomposed limestone and are of such great fertility that seven to ten ratoons are commonly cut from one planting of cane. The high lime content also improves the physical structure of the soil and prevents caking in wet weather and excessive drying during droughts So rich was the soil that for many years no fertilizer was used except the trash left after the cane harvest. In recent decades, chemical fertilizers have been used on many of the older farm lands, and ashes from the centrals and low-grade molasses are often spread over the soil. Legumes, such as cowpeas, are occasionally planted in between the rows of cane to add nitrogen.

When Cuba's sugar is in great demand, the labor resources of the island are often overtaxed. During the harvest season large numbers of engineers, chemists, and sugar experts come to Cuba from the United States, and an even larger army of immigrants comes from the British West Indies to help in the field work. The reduced crop which has been raised since the collapse of the war boom has reduced the demand for this seasonal labor. Machinery, operated by locally-reared oxen or by locally-manufactured alcohol fuel, is also lessening the demand for foreign seasonal labor. All of this results from the desire of Cuba to become less dependent on foreign markets Alternative industries have been encouraged by the government, but the transition period is hard and has been marked by revolution and unrest.

Java. This island, about six hundred miles in length and fifty to one hundred miles in width, is one of the most densely populated agricultural areas in the world. In spite of its mountainous character, it supports 37,000,000 people, largely by intensive agriculture. Its native population is industrious and is willing to work for ten to twenty cents per day under the wise supervision of the Dutch technicians and administrators. The monsoon climate is ideal for sugar cane and the volcanic soil, rich in itself, is kept in the best of condition by constant fertilization and by growing sugar in rotation with rice.

[1] During the 10-year transitional period leading up to Philippine independence, the Philippines may send 800,000 long tons of raw sugar and 50,000 tons of refined sugar into the United States annually without payment of duty. Any excess is subject to the usual tariff.

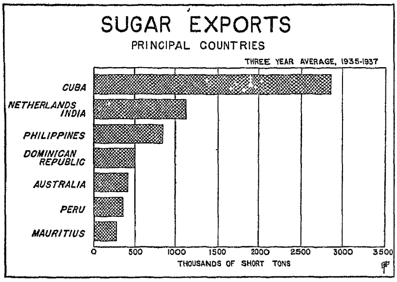


Figure 153.

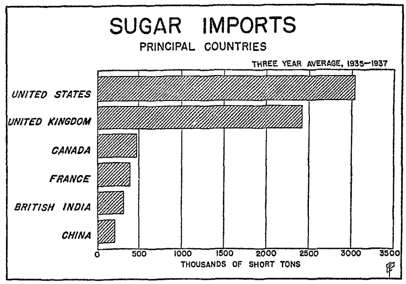


Figure 154.

Sugar cultivation is performed by white planters using native labor and native fields According to Dutch law, the planters may rent rice lands for sugar cultivation not more than eighteen months in any three-year period. This insures crop rotation and also prevents the island from becoming overdependent on imports of rice The fields are tended largely by hand and so carefully that plant diseases and insect pests are rare as compared with other sugar areas. The type of cane planted and the methods of fertilization used have been developed by careful scientific experiment. The Dutch have probably done more than any other people to improve cane technology and yields.

Java has optimum sugar conditions and the only reason it has not driven the other producers out of business is that all of its available sugar lands are in use. Much of Java's prosperity is due to the Dutch and is perhaps reflected by the tripling of the population under Dutch rule. If the Dutch can work equal wonders in Sumatra and Borneo (large parts of these islands closely resemble Java except in density of population), the sugar supply of the future may come largely from the East Indies.

The British Empire. *India.* India is the largest producer of sugar in the Empire and also ranks among the world's leading producers. Nevertheless, its sugar is insufficient to meet the local demand and it must import sugar from Java and Mauritius These islands have almost a monopoly on the Indian import market because of religious reasons. Ordinarily, sugar is refined by the use of bone black. Since bone black is an animal product and Hindus have religious scruples against touching any animal food, sugar refined in some other way must be used for the Indian market. Java and Mauritius use charcoal and other substitutes to meet Indian requirements.

The deficit of sugar in India is largely due to its low yield per acre. Poor varieties of cane are used, and the natives who own and work the sugar fields use very poor methods. Often the best soil and best care are devoted to other crops, such as rice. Fertilization is often lacking, for manure is a scarce commodity in India (dung is ordinarily dried and used as fuel rather than fertilizer) and the native feels he cannot afford chemicals. Most of the cane is grown in northern India (Indo-Gangetic Plain), where the season is very short. Usually the cane is planted in February and establishes its root system from the moisture remaining in the soil from the sparse winter rains of northern India. The plant remains almost dormant until the rainy period begins in June. It then grows rapidly until the harvest in November. Thus, the cane is in the ground only 9 or 10 months, compared with 14 to 18 months in Java and Cuba, and during the first half of this ten months' season its growth is slow. The sugar content of the cane is, consequently, low.

British West Indies. The West Indies and adjacent British Guiana produce the bulk of the British Empire sugar which enters into world trade. At one time, all of this area was devoted exclusively to sugar, but since the sugar crisis of 1890-1902, those islands which have other potentialities have reduced their sugar production. At present, both Great Britain and Canada give a considerable tariff preference to West Indian sugar. Some of the islands are specializing in the production of rum, bay rum, and fancy molasses and, in this way, avoiding competition with Java, Cuba, and the beet fields.

Australia. The Australian sugar industry is based on racial prejudice and a selective immigration policy. Australians believe that their continent should be

inhabited only by people belonging to the white race. Because of this conviction, they have encouraged white farmers to raise sugar cane in tropical Australia. Unfortunately for the "All-white Australia" policy, the conditions in Queensland are far from the optimum for sugar production Consequently, the industry has been protected by embargoes, bounties, government loans, price control, etc There is hardly a single experiment in government regulation of business that has not been tried to help the Australian sugar industry. So great has been the governmental encouragement that an area with conditions approaching the limits of production is producing a considerable export surplus which is dumped in the world market. This situation makes the Australian people at times pay twice as much for their sugar as do the English for sugar from the same region.

Other Areas. Sugar cane is also grown in the British possessions of Mauritius, the Fiji Islands, and in the Union of South Africa. There is a beet industry in Canada which supplies about half of the home market. Since 1920, the British Government has encouraged the development of a beet industry in England in order to improve soil conditions.

The Beet Industry of Northwestern and Central Europe. The beet industry in this region was disorganized and dislocated by the "World War" of 1914-1918. Many of the fields were either damaged by military operations or neglected during the war. Further damage was done after the war by peace treaties, for in many instances the new boundaries placed the sugar factories on one side of the boundary and the beet fields on the other side. This situation added to the complications of the tariff situation. During the last decade, Germany and Austria expanded beet production to use sugar exports to improve their trade balance. Beet production in central Europe now exceeds that of the years just before the war.

Central Germany and adjacent Bohemia are the most important and most progressive centers of the European sugar industry The sugar beet is one of the five most important crops of Germany (the others are rye, oats, potatoes, wheat), yet its acreage is surprisingly small, due to very intensive cultivation The beet farms are almost always well cared for, because the sugar factories, in order to obtain a high quality of beets, require that the grower shall use certain crop rotations and certain kinds and amounts of fertilizer. Some common crop rotations are:

Sandy soil	*Heavy soil*
Sugar beets	Sugar beets
Oats	Barley
Sugar beets	Rye
Potatoes	Red clover
Oats	Sugar beets
Clover	Barley or oats
Sugar beets	Cereals
	Sugar beets

Sugar beets fit into the German agricultural economy because they provide sugar for the cities, cattle feed for the farmers, and are an important part in crop rotation. More than 100,000 people are permanently employed in the German sugar industry, and many laborers are brought in from Hungary and Poland to help during the busy season. The number of temporary immigrants from Poland was more than 400,000 during one prewar year.

QUESTIONS FOR DISCUSSION

1. If Java and Cuba produced all of the world's sugar, would it be advantageous? To whom? Would it be disadvantageous? To whom?
2. Why did Congressmen from our Western states often favor Philippine independence?
3. Which states in the United States might favor high tariffs on sugar? Which would oppose such tariffs?
4. Has governmental interference helped or harmed sugar producers? Explain. Has it helped or harmed sugar consumers? Explain.

CHAPTER 25

STIMULANTS, SPICES, AND VEGETABLE OILS

THE WARMER parts of the earth have far outstripped the temperate areas in their contributions to the world's palate. It is difficult to imagine a cuisine without pepper, cinnamon, cloves, vanilla, ginger; or a social life without tea, coffee, cocoa, or chocolate. These are but the leaders among a host of flavoring substances and beverages which make up the bulk of the tropical-food exports to the temperate areas That these articles should have entered so largely into this interzonal trade is not surprising, since their flavors are unique, whereas most of the calorie-producing tropical foods can be replaced by middle-latitude substitutes. Tropical spices and stimulants enter the market in relatively small quantities, but their addition to the tastiness of the diet is decidedly out of proportion to their weight. Most American families use but a few pounds of tropical spices each year, but the lack of these would spoil many fine dishes.

The Beverage Crops

Coffee. Coffee is now used almost universally in America, Europe, and the Near East, but its spread is comparatively recent. The tree has been cultivated since early times in Ethiopia and southwestern Arabia. It was introduced into Europe by the invasion of the Turks, and, about 1650, a large number of coffee-houses were established in London. About the beginning of the eighteenth century the Dutch introduced the coffee plant into the East Indies and, somewhat later, into Dutch Guiana, whence it spread to Brazil, Venezuela, Colombia, Central America, and the larger West Indian islands.

Like most plants producing highly flavored products, the flavor of coffee depends greatly on the soil, climate, and methods of cultivation. Coffee will grow throughout the tropical-forest and tropical-savanna areas, but the best-flavored beans are produced largely in the tropical highlands with the savanna type of climate.

Brazilian Coffee. Brazil, which produces more than 60 per cent of the world's coffee, offers an interesting example of a large country dominated by one export. Three-quarters or more of the Brazilian exports in the average year consist of coffee, and, if the most highly developed part of Brazil were considered by itself, almost all of its exports are coffee beans. The "coffee plateau," as the highland area west of Rio de Janeiro and Santos is appropriately called, dominates Brazil politically, economically, and culturally. The prosperity of Brazil is very largely dependent on the value of the coffee export, which is handled by one of the few important railway nets to be found anywhere in the tropics.

The plateau is generally rolling and ranges from 600 to 3000 feet in elevation with most of the important coffee plantations lying between 1800 and 2000 feet. The most extensive and important soil is derived from volcanic rocks and is known as the *terra roxa* (red earth). This soil, although not overfertile by ordinary standards, has an excellent structure and is often as much as sixty feet deep, hence the coffee trees are able to send their roots deep into the soil and extract abundant potash and other required elements. Many *terra roxa* areas are productive for thirty-five years without fertilization, although coffee yields usually decline after the fifteenth year.

The Brazilian coffee area is on the edge of the tropics, and elevation lowers the ordinary temperatures for this latitude. Consequently, the plantations must be so located that they will be affected neither by the cold air that sinks into the valleys (frost drainage) or by cold winds that blow across high hilltops. In the cooler southern coffee areas, the trees are invariably planted on the intermediate slopes. In spite of this precaution, frosts did considerable damage in 1870, 1886, 1902, and 1918.

Rainfall is also an important factor in influencing production, and the tropical-savanna rainfall suits the coffee plant. Rainy, warm weather is desirable during the growing season, with a short, dry season when the coffee berries are being picked. A drought during the growing season greatly reduces the yield; very heavy rain during the early part of the growing

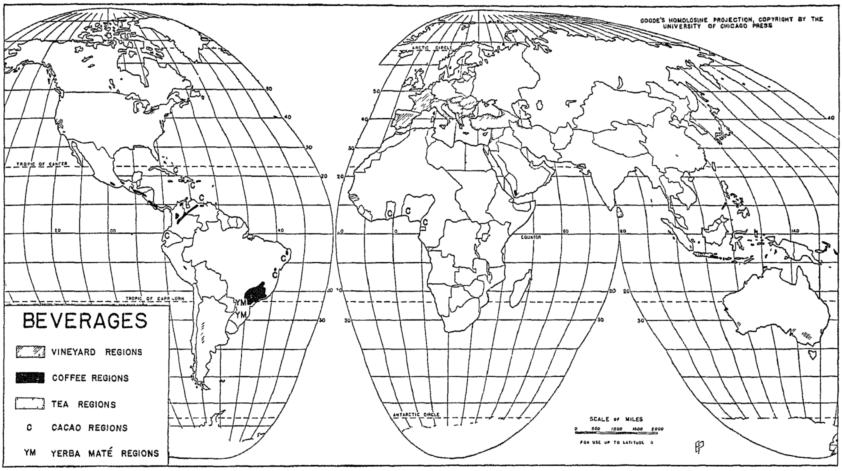


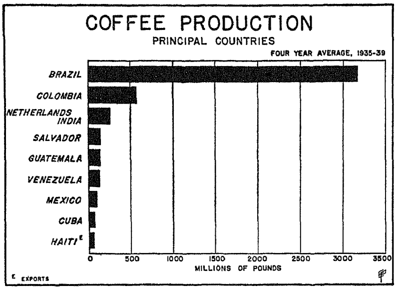
Figure 155

season may be equally harmful, as it knocks the flowers off the trees; while rain during the picking season causes premature flowering. Thus, irregularities in temperature and rainfall may cause the yield to fluctuate widely and add to the difficulties of the Brazilian Government in trying to regulate the supply to fit the demand.

The coffee industry assumed real importance in Brazil in 1835 and grew steadily from that year until 1910. Fortunately, during this period the world's consumption of coffee was increasing rapidly and, except at the end of the period, there was no reason to discourage expansion. Coffee lands were plentiful. Usually virgin forest was cleared for the new plantations, and after the brush was burned away the coffee trees were planted in rows about nine to twelve feet apart in each direction. Catch crops, such as corn, beans, and sweet potatoes, were planted in between the coffee trees and provided the only harvest during the first three or four years until the first coffee berries were ready. The maximum yield of the coffee trees is not generally obtained until the seventh year. This lag between planting and harvest often causes a high price of coffee to result in an unusually large harvest beginning six or seven years later.

Coffee in Brazil is usually raised on very large estates (*fazendas*) which are subdivided into small units of about two thousand trees (five to seven acres). Each of these units is cared for by a *colono* and his family, who receive in exchange for their services a small house, land for subsistence crops, and extra compensation for cultivation and picking. The picking and cultivation are often careless, since the wage is based on quantity rather than quality. The pickers, therefore, do not take time to separate the inferior or partly ripe berries. This extensive system of cultivation is due largely to the shortage of labor; in fact, during the harvest season, labor is often imported from other sections to supplement the work of the colonos. The result of the system has been that Brazilian coffee is not, as a rule, as high in quality as that of other places where more care is taken.

The preponderance of Brazil in the coffee industry and the great dependence of Brazil on coffee have led the Brazilian Government to regulate the marketing of Brazilian coffee and thus attempt to regulate the world price. (This system of regulation has been called "valorization" in Brazil.) In 1906 there was a carry-over from the previous harvest of 11,500,000 sacks of coffee. To avert a fall in prices, the government purchased 8,500,000 sacks. Prices and consumption rose during succeeding years, and the government supply was disposed of at a profit. In 1917, another surplus accumulated and was purchased by the gov-



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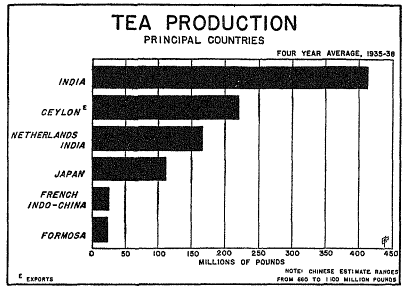


Figure 157 Probably the tea production of China is much larger than the note suggests For many non-European countries, the export figures are the only reliable statistics available

ernment, which was again able to make a profit due to the poor season and low harvest in 1918. In 1921 and 1922 similar purchases were made. Finally, an "Institute for the Permanent Defense of Coffee" was established and plans made for the regular absorption of coffee surpluses. This Institute has met with little success, for other countries have increased their production, and such large coffee stocks have accumulated in Brazil that the Institute has had difficulty in financing their holdings.

Since 1931, the planting of trees has been forbidden and the exporters of coffee have been taxed. The proceeds of this tax were used to buy up the lower grade coffee which was burned. Over 4,000,000 tons of coffee have thus been destroyed.

Other American Coffee Areas. Coffee is the standard cash crop of the tropical highlands of Colombia, Venezuela, the Central American countries, Jamaica, Puerto Rico, and Haiti. Many of these countries are nearer the equator than the Brazilian coffee fazendas, so the coffee plantations are at higher altitudes—usually from 3000 to 6000 feet. The plantations are generally small, and since they are isolated from the market only coffee of the best grade is worth growing. The product is usually packed in bags and carried by mules for long distances over poor roads to the railroad or the seaport.

Coffee in the Old World. Coffee is widely grown in the tropical highlands of the Old World, but the total product is less than one-tenth of the production of the New World. Arabia, India, Sumatra, and Java are the principal producers for foreign markets. Old World coffee is generally of better flavor than Brazilian varieties and is, therefore, much in demand for blending. In fact, most of the high-grade coffee on sale is a blend of coffees from several parts of the world *Mocha* (from Arabia) and *Java* (from Sumatra, Java, and other East Indian islands) are varieties used for strong flavor in blending. Central American coffees are generally mild but well flavored, while the cheaper Brazilian coffees provide the base for the blend.

Tea. Tea was not introduced into Europe until the middle of the seventeenth century, but it has been used throughout monsoon Asia for thousands of years. In this densely populated region where palatable drinking water is hard to obtain, tea made water drinking pleasant and also had the advantage of killing (during the process of preparation) any germs that were in the water.

The tea bush, or tree, grows in warm, rainy areas in the tropics and subtropics. It does not require especially fertile soil, but the soil must be well drained and contain considerable humus. The need for drainage and the demand for level lands for other crops usually cause tea to be grown on hillsides, but it can be grown on level lands if no stagnant water is present. Tea could be grown widely in so far as physical conditions are concerned, but to care for and harvest the tea bushes requires large amounts of cheap, skilled labor. Such labor is found only in the Orient, which has almost a monopoly of tea production.

On most tea plantations young tea bushes are set out in rows four to six feet apart, after they have attained a height of eight inches in the seedling nurseries. The soil is carefully cultivated and weeded at frequent intervals, and green manures are often added. After the bushes have reached a convenient

size, they are kept to this size by frequent pruning; this not only increases the leaf production, but enables the pickers to reach the leaves without the use of ladders. After the bushes are two years old they are plucked, and this plucking is repeated every week or ten days during the growing season Plucking the leaves is a process requiring skill, for leaves from each part of the bush are kept separate and are used to make different grades of tea Immediately after picking, the tea is prepared for market. If black tea is desired, the leaves are allowed to wither and ferment before they are dried If green tea is desired, the leaves are heated immediately to prevent fermentation. Thus, throughout the entire process skilled labor is required which must be available at the plantation.

The Shift in the Tea Trade. The first tea introduced into Europe came from China, and for several centuries the Chinese provided most of the world's tea. The hilly areas of southeastern China were well suited to the industry, both in physical environment and labor supply. China is still the world's largest tea producer, but it has lost its hold on the European market to the more efficient plantations of India, Ceylon, and the East Indies. Some of China's tea is first quality, but the bulk of its production is unreliable in quantity and quality, due to uncertain rainfall, careless preparation, and winter cold spells Chinese tea is today consumed largely at home, with considerable exports overland to Tibet, Turkistan, Mongolia, Siberia, and Russia.

The modern, European-managed plantations of Assam (northeastern India), Ceylon, and Java have obtained control of the tea trade by extensive advertising, and by producing a better-flavored, more uniform product. This has caused an important change in the producing areas India and Ceylon have more than doubled their exports since 1896. Java has nearly quintupled its exports during the same period. On the other hand, Chinese exports are but one-quarter their former volume.

Many other leaves are used in local areas for preparing hot tealike beverages. Of these, the only leaf of commercial importance is *yerba maté*, or "Paraguay tea." It is harvested from wild bushes and cultivated on plantations in Paraguay and adjacent Brazil. When brewed, it provides a pleasant drink which replaces other hot drinks in Argentina, Uruguay, and Paraguay and competes with coffee in Brazil. Within recent years, it has been advertised and sold in North America and Europe, but has not yet attained widespread use.

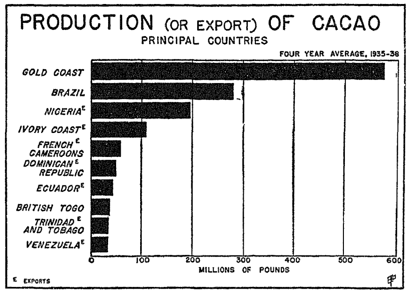


Figure 158. Note the present place of Ecuador

Cacao. The cacao tree, from whose fruit chocolate and cocoa are obtained, is a native of the New World tropical rainforest. It was well known to the tropical American Indians and provided an important food and beverage in many tribes. Its use has spread to all parts of the world, and its consumption has more than doubled during the last quarter-century. The cacao tree is somewhat more exacting than rubber in its environmental requirements. It requires a hot, continuously moist climate and fairly good soil. Strong winds tend to injure the tree, and excessive sunlight is likewise harmful. For these reasons, it is customary to grow cacao trees under the shelter of taller trees. Cacao is also very sensitive to plant diseases.

Cacao beans are contained in a pod about seven to ten inches long and three or four inches in diameter, which grows on the trunk and larger branches of the tree. The pods are picked and the beans are removed. They are then fermented and cured before being shipped to the industrialized nations for manufacture into chocolate, cocoa, and cocoa butter.

Two grades of cacao are raised which are classified as *fine* and *ordinary*. Most of the world's fine cacao is raised in northern South America and the West Indies. It is better in aroma and flavor than the ordinary grade and is more difficult to raise and prepare for market. Gold Coast (British West Africa) is today the outstanding producer of ordinary cacao. Other West African colonies, Brazil, and Santo Domingo are also important producers. Formerly, the ordinary grade represented less than half of the world's production, but recent increases in consumption have resulted in a greatly increased production of the ordinary grade. The proportionate increase in the importance of the ordinary grade was caused

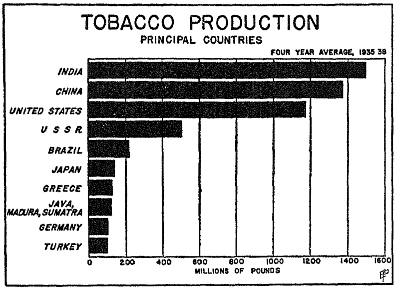


Figure 159. Very little of the huge production of India is exported.

partly by the difficulty in obtaining an adequate supply of fine cacao. After some experiments, manufacturers learned how to make the best grades of cacao products by using largely ordinary cacao. As a consequence, the price margin between the two grades has been greatly reduced.

The change in demand for the two grades of cacao encouraged a partial shift in the producing areas. Ecuador, formerly the leading producer, now produces only two-thirds of its former output. Its large plantations still turn out a good quality of fine cacao but the plantation owners have not successfully combated two plant diseases which have attacked their trees. The countries which have increased their production, notably Gold Coast and Brazil, produce ordinary cacao largely by crude methods. Gold Coast, now the leading producer, contained not a single cacao tree in 1890. The tree was introduced on a few plantations and soon after was cultivated by the natives; today, most of the Gold Coast cacao is raised on native farms of a few acres each.

QUESTIONS FOR DISCUSSION

1. Compare the cacao and rubber industries
2. What are the principal reasons for the shift of the major center of production of crops from one region to another? Give an example of each.
3. In which agricultural products is labor the chief limiting factor? Why?

Tobacco, Drugs, and Spices

Tobacco. The spread of the tobacco habit and the tobacco trade is a remarkable example of how the utilization of a new resource can influence the course of history. The use of tobacco was widespread among the American Indians before 1492 but was first introduced into Spain in 1558 and into England some years later. The habit spread so rapidly that, early in the seventeenth century, colonists in Virginia, the West Indies, and South America had made tobacco their principal cash crop. The Arabs carried it into Africa and the Orient, and the Russians carried it across Siberia and introduced it to the Alaskan Eskimos. Once its habitual use was acquired, a continuous demand for it was created, and it thus opened foreign lands to traders and provided a cash crop for new colonies. Tobacco, today, is one of the most widely used and most widely grown of crops.

The tobacco plant grows under a wide variety of conditions from 55° N. to 40° S., although the production of any one type of tobacco is limited narrowly to special soil and climatic conditions. Although it was originally a tropical or subtropical crop, its growing season is so short that it matures in regions of hot summers as far north as southern Canada. In those areas which have favorable conditions for high-grade tobacco, it is a risky crop; for tobacco rapidly exhausts the soil if one-crop agriculture is practiced. In Pennsylvania, where it is grown as a small part of a crop rotation, the yield is twice as great as in Virginia where one-crop farming, supplemented by heavy fertilization, is common.

There are many grades of tobacco produced from the same plant. One size and type of leaf may be good only for pipe or chewing tobacco, while another is used for cigarettes and still another for cigars. In addition, there are certain areas where the best types for specific uses are produced. Wrapper leaf of the highest quality for cigars is of the *Sumatra* type, produced largely in Sumatra and Java, although Connecticut, Massachusetts, and Pennsylvania also yield important quantities of the highest quality. The tropical areas, notably Cuba, produce the largest quantity of high-grade cigar filler (*Havana* type). The largest proportion of the world's cigarette tobacco is of the *American* type and is produced largely in Virginia, North Carolina, and Kentucky. *Turkish* tobacco is produced in large quantities about the eastern end of the Mediterranean, especially in Greece, Turkey, Bulgaria, and Yugoslavia. Very few of these tobaccos are used by themselves but, like coffee, are blended together to suit the tastes of different markets. Differences in flavor arise not only from the differences in soil and climate but also from differences in the methods of curing and grading.

Drugs. So many important medicinal products are obtained from plants that a complete discussion of

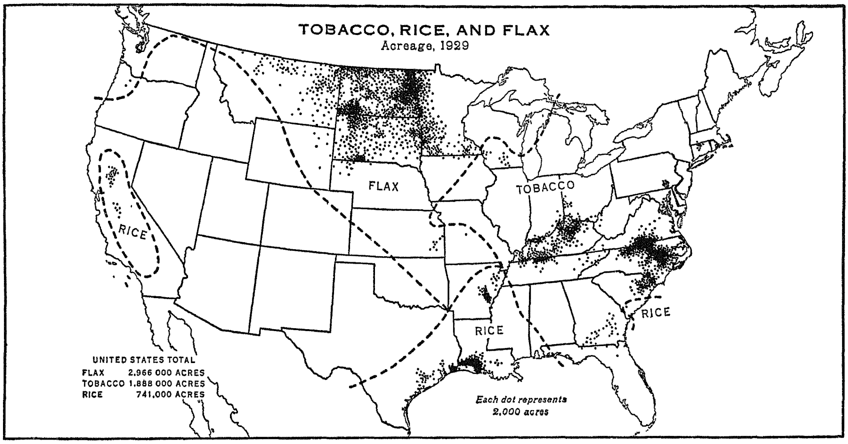


Figure 160 These crops are so different in their requirements that the U. S Department of Agriculture was able to put them on one map.

them would be overlong and monotonous. Details can be found in large encyclopedias or, in more complete form, in a pharmacopoeia. A large percentage of the medicinal plants come from the warmer parts of the world, and the most important of these are now raised on plantations rather than gathered wild. For example, *quinine,* man's best defense against malaria, is extracted from the bark of the cinchona tree. Its original home was the forest of the eastern Andes, but most of the present output is obtained from the plantations of Java. The coca bush, from whose leaves *cocaine* is extracted, also grows in the Andean region. It is used as a narcotic by the local Indians, but the commercial demand for it now is supplied mainly by the East Indian plantations. *Opium* is widely used (in the form of *morphine* and *heroin*) as a pain killer as well as by millions of drug addicts, especially in the Orient. It is obtained from the opium poppy which is widely cultivated throughout southern Asia and China.

Spices. Most of the tropical spices are indigenous to India or the East Indies. During the fifteenth century the desire to find an all-water route to India was largely due to the important spice trade with southeastern Asia. Tropical spices were costly then and were used mainly by the wealthier people of Europe to add taste to a monotonous diet. In India they were an important part of the diet of rich and poor alike.

Spices are now raised on plantations scattered throughout the tropics. Usually the plantations are located where there are good soil, skilled labor, and plenty of rainfall. Considerable skill is involved in preparing the spices for the market—hence plantations, and even regions, usually specialize in one or two spices. At present most of the world's *pepper* comes from the East Indies and the Malabar Coast of India; *cloves* come from Zanzibar (East Africa); *ginger* from Jamaica, India, and China; and *cayenne pepper* from the West Indies and Central America. *Vanilla* is the one important spice of American origin and is now produced in Mexico and Madagascar.

A few spices are obtained from the temperate areas, but they have declined in relative importance since tropical spices have become cheap. *Mustard, sage,* and *thyme* were the common European spices in the Middle Ages. In China and Japan, *soya sauce* made from fermented soybeans is a common relish which has recently been introduced into the United States. *Wintergreen, licorice,* and *mint* are also of temperate origin.

QUESTIONS FOR DISCUSSION

1. Are spices less important in the diet today than in 1500? than in 1850? Explain.
2. How does the labor problem restrict the spread of the commercial production of tropical crops?

Oil Crops

Vegetable oils are assuming a place in modern life which is rarely appreciated. They are present in soaps, paints, salad oils, lubricants, oleomargarine, medicine, and many other products and are likely to become much more important if animal fats and mineral oils diminish in quantity or become more expensive in the future. There are so many sources of vegetable oil that it is possible to discuss here only a few of the most important plants from which they are obtained. Several important oils, as cottonseed and linseed oil, have already been discussed in Chapter 22.

Palm Products. Palms and life in the tropics seem almost inseparably linked. A British Government report summarizes the importance of the palm in the tropics as follows:

> They are capable of providing for almost every conceivable want, excepting the rather exiguous clothing of the people. In places, they are indispensable: over large tracts the stems produce the only timber of the country, and the leaves are ideal for roofs, matting, and walls of houses; from the cut-open stems a large portion of the population in Polynesia and the East Indian Archipelago obtain their staple food as sago, while dates form the main article of diet among the desert tribes of the Old World; from the juice is prepared the prevailing intoxicating drink of the East, and over considerable tracts palms are the only source of sugar and oil. But to enumerate the uses to which palms may be put would be an onerous task . . . it will suffice to mention those commodities which we in temperate regions look to them to provide: vegetable fats and oils, the coarser kinds of fibre, sago, dates and matting.[1]

The Coconut Palm. Commercially, the coconut palm is the most important member of the palm family, and the production of coconuts is widespread in the wet tropics. Although known to most people in North America and Europe as the source of grated coconut, it is of much greater importance as a source of vegetable fat which is used in manufacturing margarine (a butter substitute). The fibers of its outer husk are *coir,* a coarse rope-making material; the shell is converted into charcoal which is used as an air filter in gas masks; and the sap may be converted into a sugar, a syrup, or, if fermented, into a very potent beverage (*arrack*).

The coconut palm does best with continuously warm, wet weather, provided that adequate sunlight is available. It can survive several months of drought if there is a good supply of water in the subsoil. It tolerates almost any soil except a compact clay, although sandy or volcanic soils are most often selected for coconut plantations.

[1] C. A Barber, *Tropical Agricultural Research in the Empire,* p. 24 H. M. Stationery Office, London, 1927.

Most of the world's coconuts are raised on small native-owned plantations. The trees grow from seven to fifteen years before they begin to yield and, usually, they are almost untended during the maturing period. Catch crops may be planted between the rows of trees (as on rubber plantations). The nuts are harvested either by picking or by collecting them from the ground. The husk is then removed and the nut is split in half. The nut halves are then dried in the sun (where there is a dry season) or over a fire. These dried nut meats are known as *copra* and are shipped in large quantities to the vegetable-oil factories of industrial nations.

Modern plantations have failed to displace the primitive methods of growing coconuts since, except for a few purposes, the produce and costs of the two methods are about the same. In crowded countries—as India and Ceylon—scientifically managed plantations are becoming predominant as it is more necessary to get the maximum yield per acre there.

Large plantations generally produce not only copra but coir, sugar, charcoal, and coconut for grating. Manuring, careful cultivation, and catch crops are used to get the greatest financial returns from the land.

Oil Palms. The African oil palm is a native of the tropical rainforests of West Africa and the Congo Basin. The oil pressed from the nut in some ways resembles that of the olive and is used as a substitute for olive oil. Until recently, most of the world's palm oil was obtained from wild or semiwild trees in West Africa. The trees usually grew wild, but the natives always preserved them when the rest of the forest was cleared for agriculture. The natives extracted the oil and used it as a foodstuff and salve long before it was exported to Europe. Plantations have been established in the East Indies and are now producing a better grade of oil. The present indications are that the palm-oil industry will duplicate the history of the rubber industry. The British Government is attempting to prevent further migration of the industry by training the West African natives in palm cultivation and oil extraction.

Peanuts. Peanuts (*groundnuts*) were indigenous to the tropical savanna of South America and were introduced into Africa by the Portuguese slavers. They are a leguminous crop and will grow in poor soil and improve it. The American supply comes from the Southern states where the nuts are produced for hog feed and for direct human consumption. Europe imports large quantities of peanuts from the savannas of West Africa and India. These imports are

largely converted into oil, which is used as a lard substitute in cooking.

Tung Oil. The seeds of the tung tree of southern China provide this valuable oil which is widely used as a drying oil in paints and varnishes. The tree will grow in other countries having a climate similar to that of subtropical China, and it has become the basis for a new agricultural industry in northern Florida and Mississippi

The Olive. The olive tree produces a valuable butter substitute under environmental conditions which are not conducive to dairying. The tree will grow throughout the tropics and the subtropics, provided the climate is not too rainy, but it is really at home in the dry subtropical areas with Mediterranean climate. Although some olive trees are found in every region having this type of climate, the constant care by skilled labor which is required has concentrated the growth of olives around the Mediterranean Sea. Here are densely populated lands whose peoples have, for thousands of years, performed the many operations of tillage, grafting, and pruning which must be done so carefully. Here, also, are the workers who know just when to pick the olives, how to pickle them, and how to press out the oil.

The lands around the Mediterranean Sea are rugged, but fortunately this is no handicap to the olive trees. The valleys are usually tilled intensively, while the hillsides are shared by the olive orchards and the vineyards. Any soil suits the olive tree, provided it is well drained and deep enough that the roots may draw on the moist, lower soil levels during droughts. Light limey soils are best, and the quality of the fruit is greatly influenced by the soil conditions. For example, the best pickling olives are grown near Seville, Spain. Italian olives, on the other hand, are better for olive oil.

Olive oil is so valuable that it has found very little use in manufacturing, and most of it is consumed as salad oil or as a butter substitute in cooking. The total production of olive oil is but one-half that of coconut and cottonseed oil, but its greater price per pound makes its total output more valuable. In fact, olive oil is often adulterated with the cheaper oils before it is bottled for the market.

Expansion of the Oil Industries. Mineral oils, vegetable oils, and animal fats have been so easy to obtain in the past that until the present century little attempt was made to seek substitutes. Whale oil and mineral oil are wasting resources and the possibility of future scarcity has started a search for vegetable substitutes. Many have been found, although it is not always possible at present to produce them cheaply. The discussion above has only barely touched on the most important of the vegetable-oil crops. Many unutilized tropical palms contain oils which have hardly been tried. Castor oil, long used for medicine, has been found to be a lubricant superior to mineral oil in many respects. This and other potentialities among the oil-producing plants suggest that there are huge plant resources which are yet unrealized and which may add to the carrying power of the land when the scarcity of other goods forces the botanist, the chemist, and the businessman to cooperate in developing them.

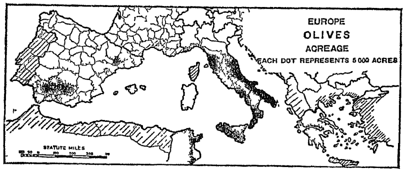


Figure 161. The diagonal lines indicate areas where olives are grown but for which accurate statistics are not available. Note the concentration of olives in the valleys and along the coast. (From Finch and Baker, *Geography of the World's Agriculture*)

QUESTIONS FOR DISCUSSION

1. Olives are not a major crop in the region of Mediterranean climate in Australia. How might this be explained?
2. In the Philippines, cacao and coconut trees are often grown together. What reasons are there for such a combination?
3. What are the advantages of tree crops for the utilization of hillsides?

REVIEW QUESTIONS ON CHAPTERS 20 TO 25

1. Check list of new terms:

habitat	boll weevil, cotton gin
plankton	Black Belt, Black Waxy
transhumance	vulcanization, latex
selective breeding	central, ratoon, bagasse
fur farming	export bounty, protective tariff
joint costs	Chadbourne Plan, valorization
mast	fazenda
Babcock Tester	copra
Merino, Romney Marsh, crossbreed	coir
Holstein, Jersey	linseed oil
long, medium, and short staple	

2. Make a table of the animals discussed in the preceding chapters. The column headings should be somewhat similar to those suggested for a crop table on page 164 (Question 2).

CHAPTER 26

FUEL CONSERVATION AND WATER POWER

An increase in man's control of power has accompanied the development of civilization. Primitive man had nothing but his own muscles until he trained the dog to hunt. In the Old World, the next step was the domestication of draft animals; in the New World such domestication was almost impossible because no first-rate draft animal was available before 1492. Mechanical power began with the invention of the water wheel in ancient times and the windmill during the Middle Ages; comparatively recent inventions—the steam engine, the internal combustion engine, and the hydroelectric turbine—have placed tremendous power under the control of man.

But this increasing control has also resulted in an increasing dependence on power. How helpless the modern city becomes if the electric current fails! How soon the factories stop if coal cannot be obtained! How useless the motor car without gasoline!

Are the world's power resources permanent? The answer depends on the resource. Water and wind power can be used indefinitely without injury to the resources. Coal resources seem adequate for several millenniums although a shortage of *cheap* coal may develop as the more easily exploited mines are exhausted. Petroleum resources are most likely to be exhausted because *known* reserves can last only a few decades.

The substitution of mineral fuels for wood, a replaceable resource, is very recent. Until the Industrial and Mechanical revolutions gave rise to a demand for fuels to run the new machinery, coal was used only in small quantities as a household fuel. With the development of the steam engine, however, there was not only an increased demand for coal as a fuel, but it became possible to mine it more rapidly because power could be applied to the process. Pumping of water and hoisting were among the first uses of the steam engine; they helped to make deep mines —and hence large coal production—possible. The development of the railroad and the steamship not only increased the demand for fuel and metals, but also made the widespread use of them possible, and allowed scattered deposits to be utilized. Thus, every development in the use of minerals has had a cumulative effect. As a result, since 1900 the world consumed more mineral resources than in all the countless ages before.

What should be done to conserve fuel resources for the future? A dogmatic answer to this question is hardly possible. The best solution will vary according to future demands, future technical developments, and future discoveries of new resources. The following pages attempt to indicate rather than solve the basic problem.

The Economics of Power Resources

At present petroleum—which needs most to be conserved—is being used most rapidly, while water power, which is unlimited and can be utilized by productive exploitation, is being used least. This paradoxical situation exists because it is usually cheaper to utilize petroleum than water power: comparative profitability largely determines the extent of the use of each.

Increasing Costs in Fuel Exploitation. As in agriculture, so in fuel exploitation, additional amounts tend to be produced at an increased cost per unit. This tendency is most pronounced in coal and hydroelectric power production. Additional amounts of coal can be mined only by digging deeper into the earth, by mining thinner seams, or by exploiting lower-grade deposits. Likewise the most accessible and most cheaply developed water power sites are used first; inferior sites, or good sites in inferior positions, must be used if hydroelectric production is greatly expanded. In the production of petroleum, the better resources are not necessarily used first because the producers rarely know in advance what costs of production will be.

The varied productivity of mineral lands results in a form of economic rent—resembling the rent of farmlands—which is based on the difference in productivity of the various qualities of mineral lands. Unlike the rent of farmlands, mining rentals (called *royalties*)

are based on the amounts produced rather than on the amount of land exploited The reason for this difference is that while the tenant-farmer is paying for the *use* of the land, the miner is paying for an *irreplaceable part* of the land It is obvious that this analysis does not apply to hydroelectric developments.

Most mining royalties are based not on an exact knowledge of the resources, but on an estimate of their value. An oil company may bid high to obtain the right to exploit a piece of land which may not produce as much as land obtainable at a lower rate.

The accuracy with which mining companies can estimate costs varies greatly from mineral to mineral. The costs for coal, iron, and other plentiful minerals can be estimated with relative ease, the costs of petroleum and minerals which occur in thin veins are relatively difficult to estimate.

The Irregular Demand for Fuels. The demand for fuel varies greatly from hour to hour and day to day, from season to season and from one period to another in the business cycle. For example, dark, cool days increase, while bright, warm days decrease, the use of electric lights and furnaces. The demand for fuel and light in winter is obviously much greater than in summer, and factories, steamships, railroads, and trucks use much more fuel during prosperous periods than during business depressions.

When fuel is demanded it is often needed in a hurry. Fuel might be stored in coal piles, oil tanks, and batteries to meet irregular demands, but adequate storage is very expensive Consequently capital and labor in the fuel industries are adjusted to meet peak demands, hence idle men and machinery during intervals of reduced consumption.

Power and Industry. Most industrial areas are located near or with easy access to sources of power. This has given rise to the erroneous assumption that power resources cause manufacturing. That this is false is shown by the many regions well supplied with power, but with little evidence of industrialization. Examples of these are the Congo Basin with its wealth of potential water power, and the petroleum fields of South America.

Such influence as power has on industrial location arises largely from the lower fuel costs near the power resources. If two areas have identical advantages in labor, capital, proximity to raw material, and markets, obviously the area with cheaper power will have a competitive advantage. Usually, however, power does not determine location except in some heavy industries.

The Mobility of Power and Fuel. The farmer must till the soil where nature placed it. Likewise the first users of water power were obliged to use it at its point of origin, hence the location of so many industrial cities around waterfalls. Likewise coal and wood were used only near their source until railway and water routes offered cheap transportation.

Today industrial cities need not be located immediately at power sites. Electric power can be transmitted hundred of miles at low cost, and coal can be transported several hundred miles by rail and many thousand miles by water without unduly increasing its price. Petroleum can be transported so cheaply that it is shipped halfway around the world.

The Problem of Substitution. The possible shortage of fuels from either exhaustion of resources or embargoes, has led to a detailed study of possible substitutes But even where substitution is possible, fuels are so basic in the modern economy that a sudden change of fuel, such as might be necessitated by a blockade, is likely to upset the entire economic organization. Under ordinary conditions, the substitution would be gradual and some of the difficulties outlined below would be met by the use of reserves set aside for depreciation.

The first difficulty is due to most fuels having several uses, while the use of possible substitutes is limited. For example, alcohol might replace gasoline as a motor fuel, but it could not be used as a lubricant or for fuel oil in furnaces and Diesel engines. Hydroelectric power may replace coal for operating machinery, but it cannot completely replace coal in smelting, nor can it serve as a source of coal-tar products.

A second difficulty is cost of substitution. Not only is the cost of production involved in this, but there are additional costs incidental to the distribution of a new product. New containers, new distribution pumps, new motors, and other new apparatus would be necessary if alcohol, for example, were substituted for gasoline.

The entire investment structure would be upset by a change. Consider the billions of dollars invested in the petroleum industry and in industries which use petroleum products as a fuel or lubricant! Few of the proposed substitutes will fit existing machinery without alteration.

Untapped Power Resources. It has been suggested that declining resources like coal and petroleum should be reserved for industries which cannot use hydroelectric power. If the potential water power in

the United States were completely developed, the total electricity generated would amount to little more than the present power used in industry alone. It could hardly be substituted everywhere for other fuels because most undeveloped power is located far from industrial regions. Unless some sources of electric power other than waterfalls and fuels could be developed, it would be necessary to effect a wholesale regional redistribution of industry to take advantage of the proposed substitution.

There are, however, several alternate power sources. Most important is the wind. Though it is very uncertain, even this handicap might be overcome if the need arose. For example, large numbers of windmills, each directly driving a dynamo, might be spread over a large area. It is probable that the wind would always turn at least a few of them, and if all were connected to a central station, a constant supply of electricity would be available. Another possibility is that windmills might be used to pump into high-level reservoirs, water that could be used to generate hydro-electric power when the windmills are still.

The earth's heat, especially near hot springs and volcanoes, is another source of power. It is already used to generate steam power in Sicily and, on a small scale, elsewhere. Waves and tides are still other potential sources. But wave-power, like wind-power, is extremely irregular, and the devices needed to harness it are very expensive. Tidal power is also expensive, except in a very few places where extremely high and low tides are combined with long narrow bays in which the tide can be dammed. The direct use of the sun offers huge potential power, but even when the mechanical problem of harnessing it is solved, other difficulties arise. In the present industrial regions, the sun is weak and often obscured by clouds, while in desert regions where the sun shines all day, there is the problem of getting the power to market.

The most likely alternative to present sources of power is industrial alcohol, which can be distilled from many fermented vegetable materials, including garbage, cornstalks, potatoes, and molasses.

Fuel Consumption in the Industrial Nations. Figure 162 shows approximately how much power is used by each industrial nation. Unfortunately the figures in the various columns are not in comparable units. The following relations may be used for rough comparisons: It requires from one to two pounds of coal to generate a kilowatt hour of electricity. One kilowatt hour equals approximately 1⅓ horsepower hours. It should be noted also that the electric power generated is obtained almost entirely from coal, petroleum, or water power listed in the preceding columns.

QUESTIONS FOR DISCUSSION

1. To what extent do the facts presented justify the government control of all power resources?
2. According to Figure 162, how well is each nation supplied with each source of power? Make a new table on a per capita basis and reconsider your answer.
3. Compare the economics of power resources with agricultural economics as to
   a. capital investment required
   b. scale of operation needed for efficient production
   c. influence of world markets

Figure 162

PRINCIPAL SOURCES OF POWER UTILIZED BY THE LEADING INDUSTRIAL NATIONS, 1937

Country	*Coal (millions of tons)*		*Petroleum (millions of barrels)*		*Developed water power (millions of horsepower)*	*Electric power generated (billions of kw hours)*
	Production	*Net imports*	*Production*	*Net imports*		
United States	458	net exports	1,277	0	17.1	121.0
Canada	15	13	3	40	7.9	27.6
United Kingdom	237	net exports	0	79	0.4	23.0
Germany (including Czechoslovakia)	269	net exports	?	45	3.8	56.0
France	44	28	0	50	5.3	17.6
Italy	0.3	13	0	10	6.0	15.0
Poland	36	net exports	3	0	0.02	3.3
Belgium	30	2	0	4	0.03	5.5
Netherlands	14	1	0	7	0.01	2.6
Sweden	0.5	9	0	8	1.9	8.0
U.S.S.R.	127	net exports	199	net exports	2.4	32.8
Japan	24	3	2	28	4.0	26.7

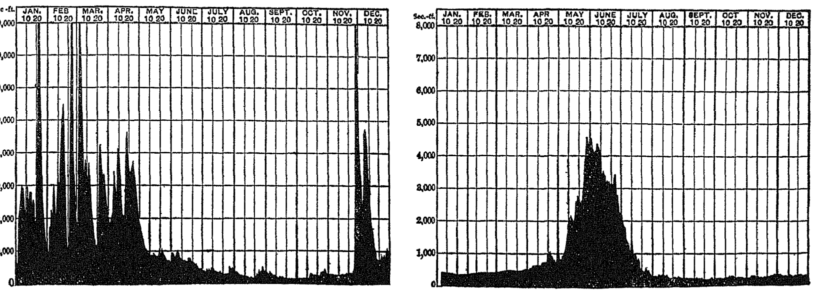


Figure 163. The flow of water in each river has its own seasonal characteristics. The diagram to the left represents the flow of the Susquehanna at Harrisburg during 1900 Its almost lakeless basin with many steep hillsides causes each rainstorm to be reflected in the flow. The diagram to the right represents the flow of the Arkansas River at Canyon, Colorado, during 1900. The water from the melting snow on the Rockies causes the single flood period (From U S. Geological Survey)

Potential Water Power

Water power is really a form of sun power. From land and water surfaces the sun evaporates moisture which is lifted by sun-generated air currents to form clouds Some moisture is then precipitated on highland areas, where it either evaporates again or runs down to the sea. The moisture that runs seaward is the potential source of all water power.

The amount of potential power is determined not only by the amount of precipitation but also by the rapidity of its descent to sea level. Some power is lost because water evaporates or seeps into the ground. Some power is also lost by friction against the stream's bed.

If water power is to be used, the supply must be largely dependable Estimates of its potential power vary with the degree of dependability. Some estimates are based on ordinary minimum flow (Fig. 164). If this basis is used, the developed power may exceed the estimated potential power because part of the developed power is available only during periods of high water. For example, note the statistics for Italy in Fig. 164. Estimates may also be made on the basis of availability during 90 per cent or some other per cent of the time. The importance of knowing which basis is used is shown by these estimates for the United States:

Water power available, ordinary minimum flow	33,500,000 HP.
Water power available 90% of the time ..	38,110,000 HP.
Water power available 50% of the time ..	59,166,000 HP.

Seasonal and daily fluctuations are caused by precipitation irregularities within the watershed, by the melting of snow, by changes in the flow of springs, and by changes in the conditions governing runoff.

Other things being equal, a country in which there are many lakes and a heavy timber cover will have a more even flow in its rivers, since both these factors cause the rainfall to be stored up and released gradually. The flow of the St. Lawrence River is very even, due to the natural storage of water in the Great Lakes. Glaciers, too, store the precipitation of the winters and release the water resulting from the melting of the ice throughout the summer. If the rainfall of a given region comes in one very short season it may be possible, by storing that water back of a dam in an artificial lake, to have a steady and considerable flow throughout the year. Here again the relief determines the availability of sites for a dam. The country may have no rock near the surface to serve as a foundation for the dam or to furnish materials from which it may be constructed. The surrounding country may slope gradually away from the stream, making it necessary to construct a long and expensive dam. On the other hand, the river may flow through a deep and narrow rock gorge—an ideal physical condition for the cheap construction of a storage reservoir.

The World's Potential Water Power. Great rainfall on high land is the primary requisite for water power. This requirement is best met in Africa. That continent is the only one that has considerable areas of high land in the zone of heavy tropical rainfall. The Congo, Nile, and Zambezi rivers, rising in the central highlands in the tropics and dropping to the coast, are the principal streams contributing to the high potential water power. Thus Africa, as shown

Figure 164[1]

WATER POWER: DEVELOPED AND ESTIMATED POTENTIAL, 1936

Figures for many countries are necessarily rough estimates

Country and continent	*Horsepower*	
	Developed	*Potential (based on ordinary minimum flow)*
World, total	60,000,000	671,000,000
North America, total	26,000,000	77,000,000
United States (continental)	17,119,610	33,500,000
Alaska	36,600	1,400,000
Canada	7,945,590	25,500,000
Mexico	450,000	8,500,000
Newfoundland	270,000	600,000
Central America	114,200	7,000,000
West Indies	40,000	200,000
South America, total	1,100,000	74,000,000
Argentina	67,000	5,400,000
Bolivia	13,500	3,600,000
Brazil	700,000	36,000,000
Chile	189,000	3,600,000
Colombia	25,000	5,400,000
Ecuador	11,000	1,300,000
British Guiana	......	3,600,000
French Guiana	......	700,000
Surinam (Netherlands Guiana)	......	1,100,000
Paraguay	500	2,800,000
Peru	55,000	6,400,000
Uruguay	......	400,000
Venezuela	15,000	4,300,000
Europe, total	27,200,000	74,000,000
Austria	1,000,000	1,550,000
Belgium	32,000	....
Bulgaria	64,000	400,000
Czechoslovakia	310,000	700,000
Denmark	16,000	30,000
Eire (Ireland)	140,000	300,000
Finland	438,000	2,500,000
France	5,250,000	6,000,000
Germany	2,550,000	2,000,000
Greece	10,000	350,000
Hungary	5,000	160,000
Italy	6,000,000	5,400,000
Netherlands	1,000	25,000
Norway	2,900,000	16,000,000
Poland	25,000	1,350,000
Portugal	72,000	450,000
Rumania	127,000	3,000,000
Spain	1,400,000	5,700,000
Sweden	1,874,000	4,000,000
Switzerland	2,800,000	3,600,000
U.S.S.R. in Europe	1,463,000	14,000,000
United Kingdom	400,000	700,000
Yugoslavia	250,000	4,000,000
Asia, total	5,400,000	148,000,000

Country and continent	*Horsepower*	
	Developed	*Potential (based on ordinary minimum flow)*
Afghanistan	2,000	700,000
Arabia	18,500	....
Asia Minor	500	700,000
China (including Manchuria)	3,500	23,000,000
Chosen	225,000	700,000
French Indo-China	......	6,000,000
India	500,000	39,000,000
Iran	......	300,000
Japan	4,240,000	7,200,000
Siam and Malay States	50,000	5,700,000
Taiwan	237,000	1,000,000
U S S R in Asia	77,000	64,000,000
Africa, total	175,000	274,000,000
Ethiopia	700	5,700,000
Algeria	400	300,000
Angola	4,000	5,700,000
Belgian Congo and Ruanda-Urundi	70,000	130,000,000
British Central Africa	......	1,700,000
British East Africa	6,200	6,700,000
Egypt	1,000	850,000
Cameroun (French mandate)	......	18,500,000
French Equatorial Africa	......	50,000,000
French Sudan	......	1,400,000
Gold Coast and Togo (British mandate)	......	2,000,000
Ivory Coast, Dahomey, and Togo (French mandate)	......	4,000,000
Liberia	. ....	5,700,000
Madagascar	4,500	7,000,000
Morocco	73,000	350,000
Nigeria and Cameroons (British mandate)	6,000	13,000,000
Mozambique (Portuguese East Africa)	......	5,000,000
Rhodesias (Northern and Southern)	2,500	3,500,000
Sierra Leone	.. ...	2,500,000
Tanganyika	800	4,000,000
Union of South Africa	7,000	2,300,000
Oceania, total	600,000	24,000,000
Australia	139,000	2,000,000
Borneo, New Guinea, and Papua	5,000	10,500,000
Celebes	500	1,400,000
Hawaii	26,000	150,000
Java	60,000	1,100,000
New Zealand	338,000	3,500,000
Philippine Islands	21,500	2,000,000
Sumatra	20,000	3,000,000

[1] *Foreign Commerce Yearbook, 1938.*

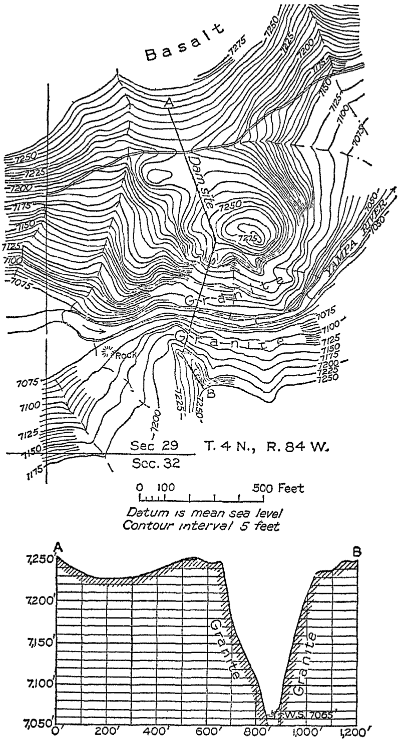


Figure 165. A cross-section and contour map of the Upper Bear dam site 14 miles south of Steamboat Springs, Colorado. Why hasn't this site been exploited? (From U. S. Geological Survey Water Supply Paper 618)

in Fig. 164, although by no means the largest or most mountainous continent, has slightly more than twice as much potential power as Asia, which ranks second. Asia is the largest continent and has the highest mountains, but is poorly supplied with rain, and very little of this rain falls upon the great highlands of central Asia where it would be most effective.

North America is very close to Asia in amount of potential water power. On the Pacific Coast, great mountains wring moisture from the westerly winds, causing heavy precipitation and many swift streams. The Rockies and the Appalachians, as well, are in zones of moderate to heavy precipitation.

South America has much less potential water power than might be expected from its high mountains and heavy rainfall. This is because the great Andean range gets very little of the rainfall except in the extreme north and south Most of the potential power in these mountains is in southern Chile, central Colombia, and on the eastern front of the mountains in Peru. A most important region of potential power is in the great block of the Eastern Highlands in Brazil.

QUESTIONS FOR DISCUSSION

1. Account for the irregularities of flow shown in Fig. 163.
2. Compare water power potentialities in a tropical-steppe region with those in a Mediterranean region having similar amounts of rainfall and relief.

Developed Water Power

The World's Developed Water Power. The rank of the continents in developed water power is quite different from their rank in potential water power (Fig. 164). Power is not developed by man everywhere it is available, but only where he has developed the manufacturing and transportation which create the need, and where he has acquired the skill and capital necessary for its use. Thus, Africa, Asia, and South America have developed very little of their potential power while North America and Europe have developed about one-third of their resources.

The Market Factor. Under former conditions of water-power development the factories using a given water power were forced to locate right at the falls. With the development of electricity, power may now be transported considerable distances in the form of electrical energy. This has made available for use potential power that was located away from routes of transport or centers of population The distance to which electrical power may be economically and efficiently transmitted is still limited, however, to two hundred to three hundred miles on the average. It can thus be seen that location with regard to near-by markets is still of tremendous importance in determining whether any specified *potential* source of power will actually be developed. In this aspect, water power has a considerable handicap as compared with coal or petroleum, its principal competitors. It is, however, under favorable conditions of market, a much more efficient source of power than either of these two and has the added advantage, mentioned above, of being inexhaustible.

Costs in Water-power Development. Water power is not a free gift of nature, as many have assumed; its

generation requires a heavy capital investment. Indeed, potential water power is always likely to exceed developed water power principally for that reason.

Even if a potential market is available near a potential power project, a multitude of other factors must be investigated to determine the feasibility of developing that power. For example, if the streams are numerous but small, the project would require numerous small units which could be operated only at a very high cost per horsepower. Likewise if the available dam sites required large dams in proportion to the storage capacity created in the reservoirs, the project would probably be too costly.

Even if physical conditions are near the optimum, heavy expenses must be incurred before any power is generated. Preliminary surveys must be made of the watershed, the proposed dam site, and the market. Land which will be flooded by the reservoirs must be purchased, and it may be necessary to pay for the relocation of roads and railroads. Stocks and bonds must be sold to raise the necessary capital. Finally, the dams, reservoirs, power plants, auxiliary steam plants (for periods of low water), transmission lines, substations, and business offices must be constructed. Throughout the period of construction, interest charges, salaries, and office expenses must be added to the initial cost of the new business.

Afterwards, there are numerous operating expenses: upkeep of the dam, power stations, and transmission lines. Furthermore, the cost of distribution is so high that the cost of the delivered power may be ten times the cost of production at the generator. Because unused power cannot be stored cheaply and because the sale of each additional unit involves little extra expense in generation and transmission, an aggressive sales campaign must be waged. Finally heavy taxes and interest charges must be paid before a profit can be claimed.

QUESTIONS FOR DISCUSSION

1. What are the disadvantages of Asia for water-power development? Why has Japan outstripped other Asiatic countries in water-power utilization?
2. Which continents are outstanding for their utilization of water power? Why?

Figure 166

ANNUAL SUPPLY OF ENERGY FROM MINERAL FUELS AND WATER POWER IN CONTINENTAL UNITED STATES

Note.—The figures, except coal equivalent, represent the equivalent of the heating power of the classes of fuel in trillions of British thermal units Data represent production, except those for oil imports, and take no account of exports or imports

Annual average or year	*Anthracite*	*Bituminous*	*Total coal*	*Domestic oil*	*Natural gas*	*Imported oil*	*Water power* [1]	*Grand total fuels and water power*	*Equivalent in bituminous coal* [2]	
									Million tons of 2,000 lbs.	*Per capita, tons*
1871-75	637	754	1,391	49	....	....	(1)	1,520	58	1.4
1876-80	718	955	1,673	101	... . ..	. .. .	(1)	1,857	71	1.5
1881-85	985	1,863	2,848	153	[3] 24	....	(1)	3,110	119	2 2
1886-90	1,195	2,474	3,669	198	[3] 264	. ...	(1)	4,221	161	2 7
1891-95	1,453	3,286	4,739	307	[3] 166	....	104	5,316	203	3.0
1896-1900	1,513	4,493	6,006	357	[3] 198	....	129	6,690	255	3.5
1901-05	1,818	7,140	8,958	612	323	. ...	209	10,102	386	4 8
1906-10	2,207	9,783	11,990	1,037	470	1	369	13,867	529	5.9
1911-15	2,427	11,527	13,954	1,486	619	72	591	16,722	638	6 6
1916-20	2,523	13,981	16,504	2,176	820	297	851	20,648	788	7.6
1921-25	2,112	12,610	14,722	3,888	1,024	569	1,105	21,308	813	7 3
1926-30	2,084	13,595	15,679	5,375	1,760	408	1,781	25,002	954	8 0
1931-35	1,460	9,207	10,667	5,336	1,824	230	1,931	19,988	763	6.1
1933	1,348	8,741	10,089	5,434	1,672	191	1,931	19,317	737	5 9
1934	1,555	9,415	10,970	5,448	1,904	213	1,896	20,431	780	6 2
1935	1,419	9,756	11,175	5,980	2,060	193	2,207	21,615	825	6 5
1936	1,485	11,504	12,989	6,598	2,330	194	2,256	24,367	930	7 3
1937 (preliminary)	1,385	11,592	12,977	7,666	2,526	165	2,405	25,739	982	7.7

[1] Fuel equivalent is calculated from kilowatt-hours of power produced wherever available, as is true of all public-utility plants since 1919 Otherwise fuel equivalent is calculated from reported horsepower of installed water wheels. Prior to 1890 data were unsatisfactory, but estimates are included in total

[2] Calculated at 26,200,000 British thermal units per ton

[3] Based on amount of coal displaced by gas, as estimated by gas companies.

CHAPTER 27

THE PETROLEUM INDUSTRY

THE MODERN petroleum industry began in 1859 with the drilling of the first oil well in Titusville, Pennsylvania, by Colonel Drake. He had no previous knowledge of oil drilling but was fortunate enough to strike the oil pool, marked by an old oil spring, on the first drilling. The refining of oil was not unknown at this time, a fact which made Drake's discovery extremely valuable. In the early 1800's a scientist in Scotland refined oil from oil shale; and, in the United States, oil as an illuminant was refined from the blubber of sperm whales. This latter demand was the basis for an extensive whaling trade in New England. At about this same time, however, the supply of sperm whales was declining rapidly and the price of illuminants was advancing markedly. Thus petroleum entered the market at a time when a substitute was needed for a declining resource.

The word *petroleum* is derived from the Latin *petra,* meaning rock, and *oleum,* meaning oil. It is essentially composed of hydrocarbons or combinations of the two elements, hydrogen and carbon. Petroleum occurs either in a solid, liquid, or gaseous state underground, though to most people, and in commerce, it means the liquid form called "crude." There are three types of crude paraffin base, asphalt base, and mixed base, a classification based upon the residue left after distillation or refining of the crude. It is obvious that somewhat different products would be obtained from these three types; the most significant difference is that paraffin-base crudes usually yield more gasoline in refining and also a better quality of lubricating oils.

Prospecting and Drilling. Petroleum has been known since antiquity because of occasional oil springs and surface seepages. However, until half a century ago little was known about the origin or location of oil pools, and most of the successful wells were discovered by accident rather than science. Oil was often discovered while drilling for water. "Divining rods," "olive twigs," and the like were used to locate oil just as they had been used by the superstitious to select sites for water wells. During the first decade of the modern oil industry "practical" oilmen despised the aid of geologists and other scientists.

Today oil companies make use of every appropriate tool of modern science. Geologists, paleontologists, and geophysicists have a well-recognized place in modern oil prospecting and are often handsomely paid for their services. These scientists cannot invariably predict whether a given site will produce a profitable well, but they can eliminate many sites where there is little chance of success. Since a well may cost from $20,000 to $190,000 to drill, the gain from any venture obviously depends on the percentage of wells that are productive.

Geologists have discovered that oil occurs in sedimentary rocks, usually in association with natural gas and water. Not all sedimentary rocks contain oil, however; it is most likely to occur in rocks of the Tertiary, Paleozoic, and Mesozoic ages and in association with certain fossils, such as foraminifera, which are characteristic of those ages. Oil seems more likely to be found near coal-bearing rocks than elsewhere.

The structure of the strata also influences the chance

ANALYSIS OF PLATE XIII: DESTRUCTIVE USE OF MINERAL RESOURCES

XIII A. Here the camera is pointed straight along the lease boundary. The Murphy Oil Company's wells are at the right and the Pacific Oil Company's wells are at the left. The attempt to offset each well by another across the boundary line is apparent. This picture also indicates that the surface configuration may indicate little, if anything, about the trend of the oil-bearing formations underground

XIII B. Ore was first mined in the Mesabi Range in 1890. The ore is a soft, porous hematite which was covered by a thick glacial drift. After this drift is removed, the ore may be mined cheaply by open-pit (strip) mining such as is shown in the photograph The steam shovels load the ore directly into the freight cars which carry it 60 miles to the Lake Superior ports. Thence lake steamers take it to Gary, Cleveland, Detroit, Erie, Buffalo and other lower lake ports. If the average rate of production in recent decades is maintained, it has been estimated that this and other Lake Superior ores will be exhausted in fifty years. There are, however, other Lake Superior iron deposits, not rich enough to be classified as ores at present, which may then be used.

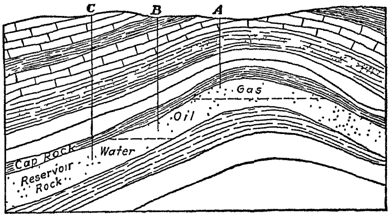


Figure 167. Cross section of an oil pool (From W A. Tarr, *Introductory Economic Geology*, McGraw-Hill, New York, 1930)

of finding oil. Petroleum is thought to result from the effect on decomposing marine organisms of heat and pressure originating in the weight of overlying sediments, diastrophic movements of the earth's crust, and igneous intrusions resulting from volcanic action. The resulting petroleum will evaporate or run away unless the rock structure provides a natural place for storage. Porous sandstones with impervious layers of shale above and below are ideal for the collection of oil. If, in addition, the strata are slightly folded, the salt water with which it is associated will tend to trap it in the domes—or *anticlines*—in the folds (Fig. 167). The petroleum floats on the water and cannot rise to the earth's surface because of an impervious layer of cap rock above it. Usually a layer of natural gas under considerable pressure is formed above the petroleum.

Probably only a small portion of the oil originally formed by nature has remained for man's use. If the rocks are folded too much, cracks in the cap rock will allow the oil to evaporate. Elsewhere much oil has been absorbed by rocks and soil and so diluted that it will never pay to recover it. Volcanic action may also have burned up large oil deposits.

The geologist's attempt to locate a potential oil pool is based upon the discovery of rock formations that are favorable to oil accumulation. By employing his knowledge of geology and physics and using such instruments as the seismograph, magnetometer, and torsion balance he constructs a picture of the subsurface structural pattern of the rocks. Surface indications denoting the presence of petroleum, such as oil or natural-gas seepages or springs, or outcroppings of asphalt or oil-bearing sandstones, are the first criteria for further investigation. The anticlinal structure of the oil-bearing sedimentary formation is another indication of a potential oil field. As the well is drilled, geologists obtain more definite information about the underground structure. Often the rock material brought up by the drill will show by its fossils whether there is a good chance of striking oil or whether the well should be abandoned If the drill strikes metamorphic or igneous rocks, further drilling is useless.

Figure 167 indicates a rather simple cross section of an oil pool. If a well is sunk at point A, at the top of the dome, natural gas will be the first product, while if tapped at B, oil will be forced to the surface by the pressure of the natural gas in the pool. A well at C will be relatively useless because it will yield only salt water.

Natural Gas. In Fig. 167, it is evident that natural gas plays an important part in bringing the oil to the surface. Where the gas has accumulated under high pressure, the oil comes to the surface very rapidly and forms a gusher. At one time wells that yielded natural gas were considered a nuisance. Now it is recognized that the gas pressure not only postpones the time when the oil must be pumped, but gas and its byproducts are, in themselves, valuable. Probably half of the natural gas of the United States has been lost because of ignorance of its significance.

Production. In a new field gas pressure is sufficient to bring the oil to the surface, but soon pumping becomes necessary. In some fields the pumps are driven by steam, generated by burning crude oil; elsewhere gasoline-driven pumps are used. In some of the older fields which have declined in production, several artificial means have been used to induce increased flow. The fact that ordinary pumping fails to produce oil from a well is not necessarily a sign that the oil in the underlying sand is completely exhausted. The more highly viscous oil may have been brought up by gas pressure and pumping, but often as much as half of the total oil in the pool remains sticking to the reservoir rock. Some of this may be recovered by forcing water and soda ash down one well to push the oil along to another. Other producers force air or gas into the sand under pressure to accomplish the same result. It is obvious that all this costs more than simply collecting oil pushed to the surface by gas pressure, or by pumping, and it can be done profitably only where some peculiarly favorable set of circumstances exists. Several such methods are used in the "exhausted" oil fields of western Pennsylvania. They are economically possible there because the oil produced is of a fine lubricating type bringing high prices and is produced close to the market, which cuts down transportation costs.

Transportation and Storage. Petroleum is almost the only liquid commercial article that is transported in tremendous quantities over great distances. Tank cars, tank trucks, and tank ships (or *tankers*) have been developed especially for the transport of oil. The tank car and tank truck are most frequently used to transport refined petroleum products. They are used, to some extent, to transport crude petroleum while a field is still so new that necessary pipe connections have not been made. River and ocean tankers transport both crude and refined products. The pipe line is so important an agency of transportation that it has become subject to the regulation of the state and national public utilities and commerce commissions in the United States in order that control of transport may not put undue power over a necessary resource in the hands of a small group. A network of feeder and trunk pipe lines connects the important oil fields in the United States with the principal refining, shipping, and marketing centers. Pipe-line construction and operation are cheaper than the construction and operation of railroads. This has made for cheaper oil and has also allowed the development of oil pools located far from any other form of transportation and under conditions where railroad construction would be too costly. In the Republic of Colombia in northern South America an oil field in the interior has been connected with the coast by a pipe line three hundred and fifty miles in length across country where railroad construction would be very expensive if not impossible. The British have recently completed twelve hundred miles of pipe lines from the Iraq fields to the shores of the Mediterranean at Haifa in Palestine and Tripoli in Syria.

Although crude oil is by far the dominant product handled in pipe lines, recent developments have brought about the piping of gasoline from refineries to distributing centers in the northeastern part of the United States. Natural gas is also piped for considerable distances to cities and industries located relatively near the source of supply.

In older fields where production has declined to a relatively small but steady amount, the oil is usually pumped directly from the wells by feeder and trunk pipe lines to the refineries, but the more active producing fields store a part of their production, either in tanks or open pools, in the field. Such collections of tanks or reservoirs are called "tank farms" and they are as characteristic an aspect of a booming field as the well rigs.

Refining. The refining of the crude product from the wells involves the most intricate problems of chemistry and economics. Figure 168 indicates the products recovered in refining and some of their uses. Methods of refining have changed according to the products in greatest demand, the nature of the crude oil available, and the changing knowledge of the chemistry and physics of refining. Until about 1900 kerosene for lighting was in greatest demand. As a consequence only crude methods of distillation which drove off the lighter gasses and gasoline as waste products and enabled the producer to separate the kerosene from the heavier oils were necessary. With the increased use of coal gas and electricity for illumination, the demand for kerosene declined. At the same time, the rise of the automobile increased the demand for gasoline. This last development has controlled the development of petroleum refining ever since. Gasoline is more volatile than kerosene and requires much more exact methods of distillation. The best genius of the research laboratories was devoted to the complete recovery of all the gasoline in the crude. The rising demand for gasoline increased not only the efficiency but the amount of crude-oil distillation. A huge supply of by-products resulted, and fortunately new markets were discovered for many of these, so that they were able to bear some of the costs of extraction and refining The markets for fuel oil were extended until most of the world's steamships have become oil burners, and oil-burning furnaces have been installed in many homes. Chemicals, medicines, roofing compounds, and cleaning fluids were

Figure 168

PRINCIPAL PRODUCTS FROM PETROLEUM REFINING

Hydrocarbon Gases	Liquefied gases—metal-cutting, cooking	
	Petroleum ether—priming motors	
	Carbon black—inks, paints	
	Fuel gas	
	Light naphthas	gasoline
White Distillates	Naphthas	gasoline
	Kerosene	
	Signal oil	
	Mineral seal oil	
Intermediate Distillates	Gas oil—cracking into gasoline	
	Absorber oils	
Heavy Distillates	Heavy oils	
	Waxes	
	Lubricating oils	
Residues	Lubricating oils	
	Greases	
	Residual fuel oil	
	Pitches and road oil	
	Coke	

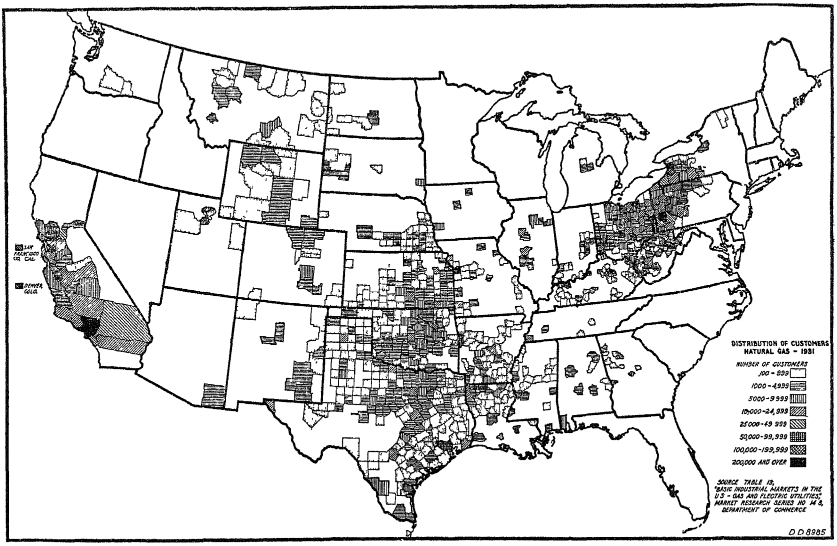


Figure 169. Most natural gas is consumed near its source. Notice the similarity between this map and a map of the oil fields (Fig. 171) (U. S. Dept. of Commerce)

developed, and new uses for by-product derivatives are constantly being discovered

The latest development of major significance has been the "cracking" process. This involves the heating of oil to temperatures of 800° to 900° F. under a pressure of two hundred pounds. This breaks down the heavier fractions into lighter ones and allows the further recovery of gasoline from heavy oils which formerly were of no importance as a source of gasoline. This process has nearly doubled the average recovery of gasoline from American crude oil.[1]

A very complex economic problem of joint costs is involved in the petroleum industry. A low price for gasoline means that there will be little attempt to crack more of it from heavier oils produced by simpler methods of refining. As a result a large supply of heavier oil is put on the market as furnace oil or fuel oil at a low price which encourages its use. If, however, gasoline prices rise, more oil will be cracked, less will be available for fuel, and the price of fuel oil will rise. Also, anything which increases the demand for gasoline usually results in an increased supply of other by-products—such as paraffin, asphalt, lubricants—and thus in a decline in their prices. Such changes in market conditions as well as in petroleum technology, keep the industry in a state of instability.

The Location of Refineries. The bulk of the world's refining is now done close to markets. The cheap handling of crude by pipe lines and tank steamers made this possible, and the larger markets for by-products near the consuming centers made it highly desirable. Perhaps the outstanding reason, however, was that freight costs on the finished products are always higher than those on the crude because the former cannot be handled in such great bulk. The result has been the establishment of great refineries in centers of population and industry. Pipe lines bring crude to major refining areas about Chicago, St. Louis, Cleveland, Buffalo, and the coastal cities such as New York and Philadelphia. The great ports of industrial nations also have large refineries using crude brought to them by ocean-going tankers. Much of the crude produced in Venezuela, Colombia, Mexico, and even California is refined in the ports

[1] At the Third World Power Congress, the research director of a large oil company estimated that cracking had already saved the United States 6,500,000 barrels of crude oil.

of the crowded industrial districts bordering on the North Atlantic Ocean.

QUESTIONS FOR DISCUSSION

1. Would it be advantageous to locate a large oil refinery at some Venezuelan or Colombian port? Why?
2. Why is it so difficult to estimate the petroleum reserves of a region?
3. Why is petroleum unlikely to be found in many parts of the world?

Petroleum Production and Trade

Crude petroleum is found in every continent, though the major fields are restricted to North America, northwestern South America, southeastern Europe, southwestern Asia, and the East Indies. Since petroleum is valuable in proportion to its weight and bulk, it can be profitably exploited at a considerable distance from the market. Pipe lines, tankers, tank cars, and tank trucks tend to unite the world's reserves into a common reservoir, except as legal restrictions limit foreign exploitation or export. While coal and water power are used fairly near their source, a large part of the world's petroleum travels many thousand miles to reach its market. Most industrial nations have a coal supply readily available to their industrial centers, but only two important industrial nations, the United States and the U.S.S.R., have an adequate petroleum supply within their boundaries. Thus petroleum plays a much larger part in world trade than coal.

The United States. This country is the largest producer as well as the largest consumer of petroleum. It is also an important importer of crude petroleum and the leading exporter of petroleum products. Fortunately, it has the largest reserves of petroleum, but they are being used up more rapidly than those in most other countries. The history of the American oil industry has been the discovery and exhaustion of a series of rich oil fields. The attempts of individuals and companies to drain each newly discovered pool has led to almost chronic overproduction in a country which probably faces an oil shortage within the twentieth century.

Eastern District (or Appalachian District). As noted previously, the first well drilled in the United States was in western Pennsylvania in 1859 For many years this district led the country, but today it yields only 3 per cent of the country's output. Most of the pools are nearly exhausted, and present production is on the basis of rejuvenated wells, flooding and pumping, and deeper drilling in the old areas. The district is still noted for the high-quality paraffin-base crude it produces for lubricating purposes, but it is of slight importance as a source of gasoline and other products.

Mid-continent District. Despite its relatively recent exploitation, which began in 1906, this district is the most important one in the world. Included in it are the important oil-producing states of Texas, Kansas, Oklahoma, and Arkansas This district produces all three types of crude—paraffin, asphalt, and mixed base—and consequently a greatly varied quality of gasoline and lubricants. Located far from the consuming markets of the East, it was not very important until the advent of tank car and pipe line solved the transportation problem. It is probably destined to continue as the largest producing field for some time.

Gulf-coast and East Texas Districts. These districts produce approximately one-quarter of the United States total and are noted for heavy asphalt-base crudes. The area is important as a source of supply for fuel, bunker oils, and lubricants, rather than for gasoline, which is usually associated with the paraffin-base crudes, though recently refining by cracking has resulted in a greater yield of gasoline. The majority of the wells are located close to the coast and in some cases wells are actually sunk into the water from barges or from artificial islands.

Rocky Mountain District. Montana, Wyoming, Colorado, and New Mexico comprise this district which stretches from the northern to the southern border of the country. Wyoming is the largest producer, but the whole district yields only 2 per cent of the country's annual output While not significant as a producer now, it apparently contains large reserves and will, with the decline in other districts and improved transportation to markets, be more thoroughly exploited.

California District. The single state of California is the second most important district, yielding 20 per cent of the national annual production. It did not achieve this rank until oil-tanker lines connected it with consuming markets. Many of the wells in this district are of the "gusher" type, due to the presence of large quantities of natural gas in the oil pools. The district is one of concentrated development and was long famed for irrational drilling which resulted in great waste and overproduction. Recently state conservation legislation has tended to curtail production and conserve the natural-gas supply. Asphalt-base type predominates in this district, which will probably continue to be a large producer for many years.

Mexico. Mexican output is concentrated largely around the city of Tampico on the Gulf of Mexico. About 1910-15 Mexican production was second only to the United States, but the field has since declined rapidly in productivity. Most of the oil is exported to the United States and the United Kingdom for refining.

South America. This continent is apparently rich in potentialities for future oil development. There are many indications that a more or less continuous zone of oil deposits stretches along the eastern foot of the Andes from the Caribbean coast to northern Argentina. Most of these potential fields are now so far from adequate transportation that there is little actual exploitation, and, indeed, there has been little really adequate examination. The greatest development is in Venezuela and Colombia, in fields lying between the outlying ranges of the Andes and the coast of the Caribbean. The Venezuelan fields about Lake Maracaibo are by far the most important, and, although shipment from there started as late as 1918, they are now producing nearly one-tenth of the world's oil and put Venezuela in third place in total production. There is some refining on the Dutch islands of Curaçao and Aruba, off the north coast of Venezuela, but much of the crude is shipped to the United Kingdom or eastern United States for refining. Both Venezuela and the near-by British island of Trinidad have large deposits of natural asphalt which are mined and sold as a paving material in Europe and the United States. Trinidad is also a small oil producer. Colombia has important oil deposits along its north coast, but as yet the principal developed area is in the Magdalena Valley. There is also an important oil field in extreme northwestern Peru. Three small fields in Argentina complete the list of South American resources.

Europe. Western Europe is second only to the United States as an oil consumer. However, except for oil shale and a very few small deposits, it lacks oil resources, and is, therefore, the major importing region. Eastern Europe, which has much less need for petroleum, has reserves almost equal to those of the United States. Production is concentrated largely in the U.S.S.R., Rumania, and southern Poland. The relatively small Polish production is marketed in Central Europe. The large surplus from the U.S S.R. is exported via the Black Sea to the refineries of southern and western Europe.

The Russian fields were nationalized along with most other Russian properties, but, though unified ownership of each pool has eliminated much duplication in drilling, it has not slowed down exploitation. The reason for this is that the Soviet Government needs foreign exchange and the sale of its oil has been one of the easiest ways to get it. The oldest

Figure 170

PETROLEUM PRODUCTION

(Millions of barrels)

Country	*Average 1926 to 1930*	*1931*	*1932*	*1933*	*1934*	*1935*	*1936*	*1937*	*1938* [1]	*Per cent world total 1938*	*Per cent each district of U.S. 1938*
United States	896	851	785	906	908	997	1,100	1,279	1,213	61 3	100.0
Eastern District	Not available	Not available	30	Not available	31	Not available	34	37	35	1.8	2 9
Mid-continent District			506		602		599	686	613	31.0	50 5
Gulf Coast District			53		84		141	177	181	9 2	14 9
Rocky Mountain District			17		18		112	141	134	6 8	11.0
California District			178		174		215	239	250	12 6	20 6
U S.S.R.[2]	93	166	157	157	175	182	199	195	202	10.2	
Venezuela	96	117	117	118	136	148	155	187	187	9 5	
Iran (Persia)	41	44	49	54	58	57	63	78	77	3 9	
Netherlands India	32	36	39	43	47	47	50	57	57	2 9	
Rumania	31	50	54	54	62	62	64	53	48	2.4	
Mexico	58	33	33	34	38	40	41	47	35	1.8	
Iraq	0.5 *	0 9	0 8	0.9	8	27	30	32	33	1.7	
World Total	1,316	1,374	1,310	1,442	1,521	1,655	1,805	2,042	1,978	100 0	

* 1927 to 1930 average
[1] Subject to revision.
[2] Including Sakhalin.

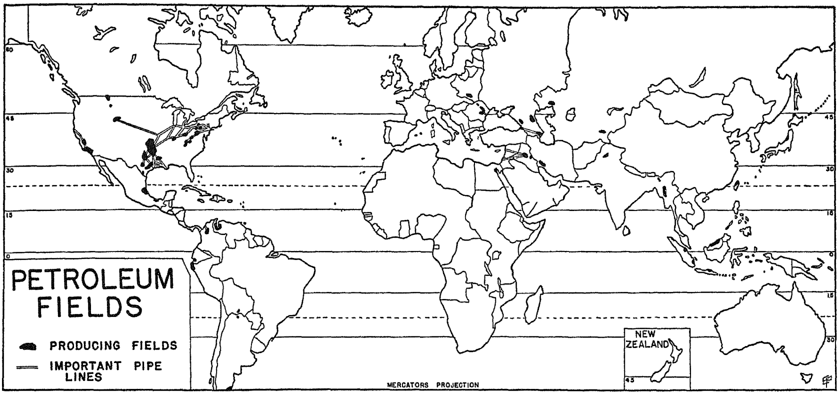


Figure 171. Many parts of the world, such as northeastern Canada, consist largely of igneous or metamorphic rock in which petroleum is not likely to be found

Russian field is near Baku on the Caspian Sea. Its product is shipped by pipe line to the steamers on the Black Sea and by boat across the Caspian Sea and up the Volga River to the industrial centers of Russia. A newer field just north of the Caucasus Mountains ships to Russian and foreign markets by tank car. A small field on the island of Sakhalin off eastern Siberia exports to Japan.

Other Fields. The rich fields of Iran (Persia) and Mesopotamia (Iraq) are exploited very efficiently by British companies. Likewise, the fields in the Dutch East Indies are carefully exploited by Dutch interests. The pools in these fields are controlled as a unit and competitive drilling is therefore unnecessary. A large interest in each company is owned by the British or Dutch governments, which discourage rapid exploitation as they wish to retain the fields as a military reserve. Another field of unknown potentialities has recently been brought into production in northeastern Arabia.

QUESTIONS FOR DISCUSSION

1. Why does the United States, which produces more than 60 per cent of the world's petroleum output, also import petroleum?
2. Why is there a strong tendency toward the development of monopolies in most aspects of the petroleum industry?
3. Oil stocks are often considered highly speculative. Is this equally true of stocks in holding companies, pipe-line companies, retailing organizations, and drilling companies?

Problems of Conservation

Petroleum is one of the most easily exhaustible mineral resources, not only because of the ease and rapidity with which it is exploited, but because of the meagerness of known reserves. Some experts think that a few decades will see the exhaustion of fields capable of large and cheap production, and that growing scarcity will soon bring about increasing prices, with consequent disturbances in many dependent industries. Similar predictions were made several decades ago, and the time of prophesied exhaustion has come and gone, yet the estimated reserves are greater today than they were a quarter of a century ago. However, today's estimates are probably much more accurate than those of the past, and the rate at which new fields are being discovered is slowing down. As a result, practical oil men are taking steps to assure a supply of substitutes for the future and to conserve the resources at hand.

Multiplication of Wells. One of the outstanding handicaps to a wise use of oil resources in the United States is the Anglo-Saxon concept of property in land. In its simplified form the English Common Law assumes that the owner of the land's surface owns also the minerals lying under that surface. This theory is closely adhered to in the mining of nonliquid minerals where surveying methods make it easy to determine, even in complex underground workings, where one man's property ends and another's begins. How-

ever, petroleum flows underground through the porous reservoir rock. Though there are several owners of the land over an oil pool, all of the recoverable oil may, nevertheless, be drained out through wells on the land of one owner. In the early days of the petroleum industry, the courts decided that the only valid claim to property in petroleum was actually to bring it to the surface on the claimant's land. For this reason it is customary for a property owner, when giving a lease allowing the exploitation of his land, to stipulate that for every well drilled on the land of surrounding property owners within a stated distance of his boundary, the lessee must also drill a well to offset any possible drain. If this were not done the lessor might get little income, because he is paid largely on the basis of the number of barrels brought to the surface through his land.

Whenever a new field is discovered drillers rush to obtain petroleum leases from the owners of property believed to contain oil. If there are many owners, there is a wild rush to put down as many wells as possible so that each may get his share of oil. Multiplication of wells tends to bring about rapid production and a rapid exhaustion of the gas pressure. The production is not due to any market demand, but to the fear of a legalized "theft" of oil by the lessees of neighboring property owners. Multiplication of wells in a small area reaches its climax in some of the California fields, concerning which the following extreme example is taken:

> Building lots (50 x 120 feet or less in size) often constitute drilling sites in urban areas. Some leases provide scarcely enough space on which to construct the standard derrick with its 24-foot base, pump house, storage tanks and boiler plant Commonly, five, ten, or more wells are drilled where single wells would have been capable of extracting the recoverable oil. In town-lot districts nearly every well may be regarded as an off-set well, and consequently leases call for immediate drilling when wells appear on adjacent property. Excessive crowding naturally ensues along with a pattern of well-spacing which is highly irregular and which lacks all semblance of orderly and conservative development.[1]

Multiplication of wells far beyond the number necessary and the rush to get the oil to the surface causes the anomalous situation of overproduction of an easily exhaustible resource, even in the face of declining prices. In many Latin countries, in Russia, and throughout the Orient, the owner of the surface is not considered to have any claim to minerals underneath, and the government, in whom the right is vested, may give exclusive rights to exploitation of an entire pool This system allows the producer to develop the field as the market warrants it. In the United States, agreements among owners of oil-bearing properties have been suggested so that pools may be developed as a unit. Such agreements are, however, theoretically "conspiracies in restraint of trade" and, as such, have doubtful legality under the Sherman and Clayton antitrust acts. Some states, notably California, where the situation has been most ridiculous, have passed laws forbidding the drilling of wells within one hundred feet of the lease boundaries, and this has had some corrective effect. Even in England where this theory of land ownership originated, attempts are being made to vest the ownership of all petroleum resources in the government, just in case any oil is ever discovered there. In the United States this legal situation is, without doubt, the leading barrier to the "wise use" of the oil resources.

Other Wastes of Production. Oil actually existing in a pool is only partially recovered, even by pumping, and oil producers and government research agencies are continually experimenting with methods designed to improve the situation. In some cases oil left in the sands after pumping has ceased to give any yield remains without loss, to become a resource if some means of recovery is found in the future. In others it is permanently lost because the sand becomes impregnated with salt water.

The loss of natural gas has been tremendous in the past. It is now being utilized as an industrial or domestic fuel wherever markets are available, but many oil fields are far from consuming centers. Another increasingly important method of utilization is the refining of high-volatile gasoline from the natural gas and using it to improve low-quality gasolines. This sort of mixing makes possible a "tailor-made" gasoline to fit almost any development in engine construction.

More Efficient Consumption. Many developments of a technical nature not directly concerned with the oil industry are also acting to conserve the supply. Every improvement in the efficiency of the gasoline engine, the development of the Diesel engine which uses low-cost fuels efficiently, and improvements in bearing materials which cut down the consumption of lubricants—all act to conserve the petroleum supply and to make every barrel of crude mean more in labor performed.

Supplementary Petroleum Reserves. Petroleum can be obtained from oil shale or coal by distillation.

[1] Clifford M. Zierer, "An Ephemeral Type of Industrial Land Occupance," in *Annals of the Association of American Geographers*, Vol. XXVI, No. 3, p. 135.

At present such production is, because of high costs, generally unprofitable except where blockades or tariffs make it difficult to import petroleum.

Oil Shale. This is not a new source, the industry being more than a century old in Scotland and France, both of which lack reserves of liquid crude. It is estimated that in the United States alone 92,000,000,000 barrels of oil can be recovered from oil-shale deposits. This is approximately six times the amount of crude petroleum produced in the United States from 1857 to date and nearly three times the world's production of the same period.

Coal and Lignite. Petroleum produced from the bituminous coal and lignite deposits of the United States and much of the rest of the world, like oil shale, is largely dependent upon the supply of, and the demand for, petroleum. The deciding factor is price. Already Germany is providing much of her own needs from this source.

The potential supply of petroleum from these two sources, bituminous coal and lignite, is approximately 550,000,000,000 barrels, an amount sufficient to supply the needs of the world for many centuries. Oil from coal and lignite is likely to be used before the large-scale exploitation of oil shale. In the first place bituminous coal and lignite are scattered throughout the entire world, with large deposits near both market and transportation facilities. Furthermore, the residue from the distillation of bituminous coal and lignite, unlike the residue obtained from oil shale, is a valuable fuel.

To Germany must go the credit for development of the most important process of recovering petroleum from these sources. The *hydrogenation process* uses low-grade coals and recovers some 90 to 135 gallons of crude oil to the short ton of coal. The fact that the world's coal resources become the world's oil resources indicates the true value of this discovery. In Germany the development of "hydrogenation" has been such that gasoline is now produced commercially as one source of automotive fuel.

Agricultural Substitutes. All mineral substitutes for petroleum, such as coal products, are necessarily exploited destructively and the end of their supply will eventually be reached. Agricultural products can be produced by productive exploitation, hence they offer possibilities of permanent supply. Among the petroleum substitutes suggested are.

1. Alcohol from the fermentation of grain, sawdust, molasses, potatoes, and garbage
2. Vegetable oils for lubrication, such as cottonseed oil, palm oil, and castor oil
3. Gas and other products from the destructive distillation of straw, cornstalks, and other wastes.

The Cost Factor. The preceding discussion indicates that there is little danger of a petroleum scarcity in the immediate future if oil shale and coal resources are tapped. But the petroleum which is being used at present is cheap—hence its widespread use. If crude oil must first be obtained by a distilling process, then the cost of the resource is increased and many of its present uses would become unprofitable. If the price of fuel oil, for example, were to double, it might make the use of oil burners for heating uneconomic Such changes would involve the discard of much expensive machinery and have widespread repercussions on our whole economic structure.

QUESTIONS FOR DISCUSSION

1. Is there any relation between the price of petroleum and the known reserves? Why?
2. What petroleum products do you use? What inconveniences would result if you were obliged to use substitutes?
3. What advantages does petroleum have over alternative fuels (coal, wood, alcohol, electricity)?
4. What is the military importance of petroleum? Analyze the availability of petroleum to each of the great powers.

CHAPTER 28

COAL

WITHIN the past two and one-half centuries the economic life of the world has been transformed by power, and the bulk of that power has been derived from coal. Soon after the invention of the steam engine by James Watt in 1769, coal became more important than the older sources of industrial power—the muscles of men and animals and the force of wind or falling water—and deposits of coal began to exercise their influence on the nature and location of industry and on the distribution of population. The use of the power from coal caused the factory system to grow rapidly in the Western World and to begin its extension toward the Eastern; it made ocean shipping speedier, safer, and more economical, and allowed man, at last, to transport bulky goods cheaply and swiftly over land routes by means of the railroad. Today, coal is still the largest single source of mechanical power, but the relative importance of oil and hydroelectric power is growing rapidly and they are already displacing large quantities of this fuel.

The Origin and Kinds of Coal

Coal is a sedimentary rock, but instead of being formed originally by the accumulation of silt, sand, or gravel, it is the remains of semidecayed plants which have been compressed, hardened, and otherwise altered.

Peat. The origin of coal may best be illustrated by the peat bogs which exist in many parts of the world today—for they represent, on a small scale, the first steps in the formation of coal. Peat is a jelly-like mass which is being formed, constantly, in swampy areas from the semidecayed remains of plants. Although some peat exists in nearly every swamp, shallow, fresh-water swamps with moderate climate seem to be ideal. As the plants in such a swamp die, their stalks and leaves fall beneath the water level. They decay and form acids which impregnate the water of the swamp and arrest the further decay of the organic material. As the plant remains accumulate, they compress the material beneath and press out some of the water. The resulting mass looks like wet sod, and in it the forms of the plants are often traceable. In parts of Europe where income is low or coal is poor, this peat is dug out of the bog, allowed to dry, and is then used for fuel. It is fairly satisfactory for this purpose, because it is largely composed of carbon, hydrogen, and oxygen—the principal ingredients of coal, petroleum, and wood.

Although these first steps toward the formation of coal are proceeding in some parts of the world today, the special conditions necessary for the growth, partial decay, and accumulation of the tremendous amount of vegetation responsible for the great coal deposits were present only in the Pennsylvanian, late Cretaceous, and Tertiary geologic ages. Then, the climate was conducive to the rapid growth of enormous plants and there were large areas of shallow swamps which were slowly sinking. These two conditions permitted the accumulation of peat hundreds of feet thick and allowed it to be buried under the other sediments which were laid down at a later period.

The Effects of Burial and Pressure. As these great beds of peat became buried under increasing weights of sediments, the pressure further compressed the material and caused chemical changes which tended toward lower percentages of most of the elements except carbon. In some instances, pressure due to folding and warping also helped this process, and most of the hardest coals today are found in regions where folding has been active.

The Classification of Coals. In general, the quality of coal varies directly with the amount of pressure and heat to which it has been subjected and, therefore, with its hardness The commonest classes are lignite, bituminous, and anthracite in increasing order of hardness.[1]

[1] A more detailed classification recognizes subdivisions of these groups and uses the terms "lignite," "subbituminous," "bituminous," "semibituminous," "semianthracite," "anthracite," and "superanthracite"

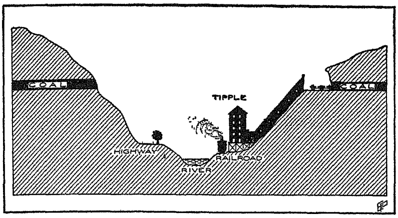


Figure 172. Cross section of a bituminous coal seam showing how a dissected plateau helps to solve the problem of transportation.

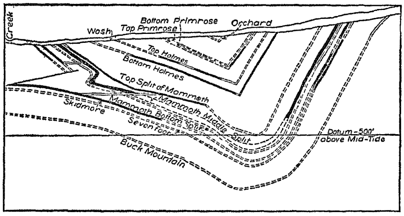


Figure 173. Cross section of an anthracite coal field. (Courtesy of the Pennsylvania Geological Survey)

Lignite. This is often called "brown coal" and is woody in appearance. It is but a step higher than peat and the similarity to the latter is readily recognized. The proportion of moisture and volatile matter is high and the carbon content is low. It has very low heating value, burns with a great deal of smoke, and crumbles with much handling. As a result, it is seldom used except within a short distance of the mine and then only where other coal is expensive.

Bituminous Coal. Most of the coal used in the world today falls within this broad class. It ranges in quality from low-rank bituminous, high in volatile matter and with considerable moisture content, to the high-rank coals—such as Pocahontas and New River, from the West Virginia fields, or some of the Welsh coals—all of which have the highest heat efficiency and are low in moisture and volatile matter. Volatile matter is important because it results in gas and smoke when the coal is burned. If the coal is to be used solely as a fuel and the heat content is the sole consideration, low-volatile coal is preferable. This volatile matter is, however, the source of many coal by-products and if gas and other products are being manufactured from the coal as a raw material, the high-volatile—or low-to-medium-rank bituminous—coals are preferred.

The best coking coals also fall within this class. Coke is a hard, gray, brittle, and porous material made most largely from bituminous coal by heating it in closed ovens to drive off the volatile matter and increase the carbon content. It is a vital necessity in the smelting of many ores and serves both as a source of heat and as a source of carbon. Its use as a domestic fuel—because of its high heat content, relative smokelessness, and low gas content—is increasing. All of the coals in the bituminous class are commonly called "soft coal" in the northern United States to differentiate them from anthracite. In the coal trade, there are definite specifications to cover each of the various qualities of bituminous, and prices vary largely according to the heat value.

Anthracite. This "hard coal" is the ultimate product in the process of coal formation. It is usually found where folding and warping have made the coal unusually hard. Most of the moisture and volatile matter have been driven off in the process and the fixed-carbon content is usually better than 90 per cent. Anthracite does not ignite easily, but holds its fire well, has a high heat value, gives off little smoke or gas, and leaves little ash. For these reasons, it is the preferred coal for domestic heating where it is

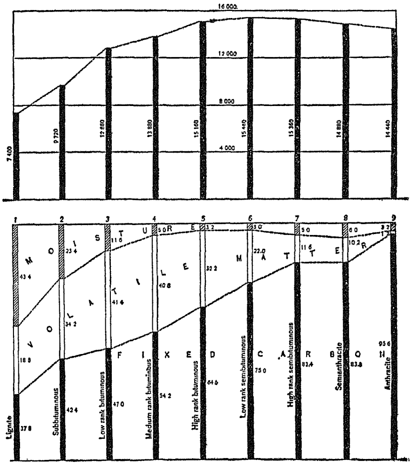


Figure 174. Heat efficiency (above) and composition (below) of the different types of coal. (From U. S. Geological Survey, *Professional Paper 100-A*)

available. Because of the large domestic market, the greater cost of mining, and its scarcity, it is used for industrial purposes only close to anthracite deposits or in sizes not suited for domestic heating.

Figure 174 summarizes the variations in heat efficiency and composition of the different types of coal and shows the orderly progression in quality from lignite to anthracite.

Coal as an Environmental Factor

Coal, as almost any other element in the physical environment, does not necessarily have any marked influence on man. Historically, coal was always present, exactly where it is now, but it came to be an important part of the realized environment only within the last two and one-half centuries. It had to await the demand for large quantities of power and man's acquisition of techniques of converting coal into power before it was exploited to any considerable extent. This historical approach helps to reveal the principles underlying man's present adjustment to coal. There are countries with large coal resources but with little industrialization—such as China—and there are countries with high degrees of industrialization but little or no coal—such as Japan or Italy. These latter countries have been forced to import coal and to develop supplementary sources of power, but the lack of coal at home has not prevented its use. The most direct effect of the distribution of coal resources has been to influence the *kinds* of industry pursued and the distribution of those kinds within industrialized nations.

Coal in an Industrial Nation. Once exploitation is actively begun in response to the demands of a growing industrialization, what influence is the presence of coal likely to have on the distribution of industry and population? This question can be answered by observing conditions in Great Britain, Germany, and the United States. Prior to the Industrial Revolution, much of the population of Great Britain was concentrated in the rich agricultural districts of southeastern England. However, following the introduction of the factory system, industrial cities began to spring up around the coal fields bordering the Pennines and in the Rift Valley of Scotland. This movement continued until the great majority of British industries and all, except one, of the large British cities were located on, or beside, the coal fields. At the same time the center of population shifted and is now located in the coal regions. The same tendency is noted in Germany, where the coal fields of the Ruhr, Saxony, and Silesia contain the majority of great industrial cities and the most dense populations. In the United States, the use of coal as a major source of power brought an important increase in industries and population in and near the coal districts of Pennsylvania, Ohio, Indiana, Illinois, and Alabama.

Coal fields attract industries, and consequently population, because fuel costs are cheaper in close proximity to the mines. Coal is bulky and heavy in proportion to its value, and is, consequently, costly to move. As it is the predominant source of industrial power, and the principal fuel for smelting operations, it is decidedly advantageous for many industries to locate near the source of production. This is especially true of those industries which require large amounts of power, and such activities as the manufacture of iron and steel and gas which make extensive use of coal as a fuel or raw material. Industries in which fuel is required in but small amounts or in which hydroelectric power may be used are less affected by the presence of coal resources.

Coal and the Economic Competitive Struggle between Nations. The possession of coal is a decided advantage to an industrial nation, for it means lower fuel costs. Such countries as the United States, Great Britain, Belgium, and Germany thus have an advantage over their competitors in those industries where fuel makes up an important part of the cost. These nations are thus outstanding in the manufacture of iron and steel, machinery, chemicals, and bulky products of many types. A progressive nation possessing coal is likely to develop a more active and diversified industrial life than an equally progressive state possessing little or no coal. This contrast is well illustrated by Belgium and the Netherlands. Belgium possesses considerable deposits of coal and early became one of the leading industrial nations of Europe. Large amounts of iron and steel, machinery, textiles, glass, and chemicals were produced and exported. The Netherlands, on the other hand, was long thought to possess no coal. As a consequence, its people specialized in agriculture and commerce. Such manufacturing as took place was concerned with the preparation of agricultural products or other industries which required little fuel. The recent development of coal in the Netherlands is partly responsible for the rapid industrialization which has characterized the country during the present century

Effect of Nature of Deposits. Many physical factors affect the cost of utilizing a given coal deposit and, therefore, its likelihood of development. The

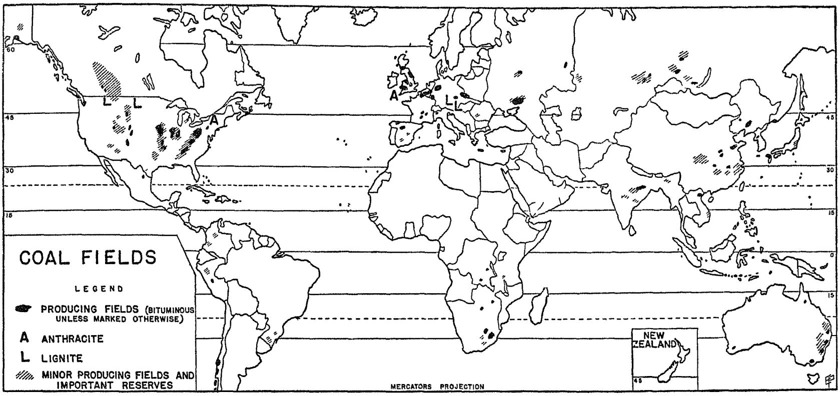


Figure 175. Compare with Fig. 171. In general, do the coal fields occur in petroleum-producing areas? Are there any large areas where coal is lacking?

more important are summarized in the following paragraphs.

Position. Few industries which use coal are located solely with regard to coal deposits. Other factors favorable to the location of industry—such as labor supply, markets, raw materials—must also be favorable. Since transportation is the force that makes any resource available, position is not so much a matter of miles as of cost. Cheap water transport or downgrade hauls by railroad may allow coal to be marketed relatively far from the mine.

Size of Deposit. If the deposit is large, it may become economical to develop it, even though there are many physical handicaps. Small, scattered deposits increase cost of extraction and decrease the probability of development.

Nature of the Coal. It may pay to exploit even small deposits if the quality of the coal is high. On the other hand, medium-grade coal close at hand may be neglected and high-grade coal imported from a distance, especially if it is good coking coal or of the "smokeless" varieties preferred for railroad and marine fuel.

Thickness of Seam. The thickness of the coal seams has a decided effect on the cost of production If seams are less than three or four feet in thickness, it is usually necessary to clear away a great deal of worthless rock in order that miners may work in the seam. Perhaps the ideal thickness for deeply buried seams is six to seven feet. This allows the miner to work standing upright, to reach all of the coal in the seam, and to handle only paying coal in driving his tunnel along the vein. It is possible to exploit much thinner veins in highly valuable coals, such as anthracite, because of the higher price received for the product.

Continuity and Dip of the Seam. Where the coal field is much faulted and folded, seams are seldom continuous over any considerable distance and may dip at sharp angles from the horizontal. These factors make for difficulty and expense in transportation inside the mine and make it necessary to handle a great deal of worthless rock to follow the coal seam. These conditions are usually present in anthracite fields because it was the very faulting and folding that created this highly valuable coal.

Hardness of the Coal. While hard coal is usually good coal, it is more difficult to mine, requires more expenditure for blasting materials, and cannot be mined as readily by machinery as softer coal.

Depth Below the Surface. If a considerable quantity of coal lies relatively near the surface, it may be economical to remove the covering of rock and mine it by "open-cut" methods with steam shovels. Great depth requires deep shafts, expensive application of power for hoisting, and complicates the problems of drainage and ventilation.

Nature of Surrounding Rock. Where mining requires tunneling, soft rock surrounding the coal makes expensive timbering of tunnels and shafts nec

essary, while hard rock, free from faults and breaks, may require very little.

QUESTIONS FOR DISCUSSION

1. How does the distribution of coal affect manufacturing?
2. Is coal mining conducted under increasing costs? What determines the "point of diminishing returns"?
3. Does coal mining have any problems of overproduction similar to those in the petroleum industry? Do you think the estimates of coal reserves are more reliable than the estimates for petroleum?

Geographic Distribution of Coal

The world is endowed with a vast amount of coal. It is estimated that within 6000 feet of the surface there are 7,397,553 million metric tons of coal, or enough to last some 6000 years at the present rate of consumption. This does not mean, however, that coal can be wasted with impunity or that the exhaustion of resources may not work great local hardships. The most easily mined and highest-grade coal is always mined first. After this is removed it is necessary to mine the deeper or thinner seams or poorer grades. In either case, fuel costs rise, and the industrial life of the nation is handicapped. Older mining areas, such as those of Great Britain, show present evidences of this change.

Not all areas of the world are equally well endowed with coal (Fig. 175). North America contains some 69 per cent of the entire reserves, while the United States alone has slightly more than one-half of the world's total. Asia ranks second to North America, but contains only about 17 per cent of the world reserves. Unfortunately, however, many of the Asiatic reserves are far from markets and transportation facilities are frequently lacking Europe ranks third in importance, but has considerable reserves in proportion to its area and has the added advantage of having most of its reserves in close contact with markets.

While the highly industrialized countries of North America and Europe contain only 60 per cent of the world coal reserves, they nevertheless produce more than 80 per cent of the annual average world output These large producing nations have populations that are progressive, industrially and commercially active, and have very well-developed transportation facilities. It is significant that all those countries producing more than 50,000,000 tons annually are located in North America and Europe. With the exception of China, India, and Japan, there are no nations in the other continents producing more than 11,000,000 tons annually, which is even more striking when compared to the world total of 1,250,000,000 tons. Oceania (especially Australia and New Zealand) has abundant reserves in proportion to its population, but is considerably behind the first three continents in total reserves. Africa and South America are very poorly supplied with coal, a lack which may have an important influence on the future industrialization of these continents.

Coal in North America. While this continent is richest in reserves and highest in production, there are large areas where coal is absent or poor in quality. Mexico and Central America have only small and scattered deposits, coal is scarce on the Pacific coast of the United States, and appears adjacent to cheap tidewater transportation only in the small deposits of Nova Scotia. Figures 169 and 175 indicate that, with the exceptions mentioned above, coal is very satisfactorily distributed within these two countries. There are, however, handicaps of quality and of position in relation to other factors favoring industrialization which decrease the value of many deposits. Between the Mississippi River and the Rockies in the United States, coal is low in quality, although high in quantity. The Eastern and Interior fields in the United States are relatively near to the industrial areas of the northeast and the Lakes states, but the heart of Canada's area of densest population and greatest industrialization (Montreal to Kingston, Ontario) is so far from either the high-grade Nova Scotian or low-grade western Canadian coals that deposits in the Eastern and Interior Provinces of the United States are nearer and cheaper of access. The American South has good coal far in excess of its present consumption. The West has scattered deposits, some of high grade, more than sufficient for present or future needs except in the Pacific states where abundant petroleum and water power make up for this handicap.

The Eastern Province. This, the most important coal-producing province of the United States, contains 90 per cent of the reserves of high-quality coal in the country and is the source of the coal for the great industrial districts of the Eastern seaboard, the nearer Middle West, and the principal consuming areas of Canada. It contains the world's most productive anthracite field in northeastern Pennsylvania and varied qualities of bituminous coal in the great Appalachian field which stretches from western Pennsylvania to Alabama.

The Pittsburgh bed in western Pennsylvania, eastern Ohio, and West Virginia is the world's largest deposit of high-volatile gas and coking coal. It has

been one of the main factors in the localization of iron and steel industries in the Pittsburgh area and along the lower Great Lakes. This bed not only contains large quantities of excellent coal, but its mode of occurrence and position make for cheap exploitation. The seam lies almost perfectly horizontal and averages seven feet in thickness over an area of 2100 square miles. Because it underlies the upraised and dissected Appalachian Plateau, the streams in cutting toward base level have exposed the seams on the sides of the valleys! This permits the mining of the coal above the level of the railroads which follow the banks of the principal streams. The network of rivers allows for cheap barge transport from many parts of the field, and railroad haul, either east or west, is largely downgrade.

Although the coal of the Pittsburgh seam is used in tremendous quantities for steaming purposes, some of the coals of southern West Virginia, Kentucky, and Tennessee are of the low-volatile type which is ideal for this use. Coal from eastern outliers of the Appalachian field in western Maryland, Virginia, and North Carolina has a downgrade rail haul to the ports of Hampton Roads from which it is shipped by coastwise vessels to all parts of the Atlantic seaboard and is exported in small quantities.

The southern extension of the Eastern Province supplies most of the coal to the industrial South and, in the vicinity of Birmingham, Alabama, supplies the fuel for the iron and steel center which has grown up there.

The Interior Province. Although coal is well scattered throughout this area, much of it is low in quality or distant from markets. The deposits in Illinois and Indiana are of most importance because of their moderately high quality, and the nearness of the deposits to the industrial centers of the Great Lakes region and to a large market for domestic consumption throughout the Middle West.

European Centers of Production. The United Kingdom, Germany, the U.S.S.R., France, Poland, and Belgium are the leading producing countries on the European continent and are important in the order named. The chief centers of production in the United Kingdom are: Scotland, especially in the valley between Glasgow and Edinburgh; the northeast, in the basin of the River Tyne about Newcastle; the Midlands, about Manchester and Birmingham; and on the south coast of Wales, about Swansea. There is another important series of fields more or less continuous from northern France and Belgium eastward across Germany to southern Poland and Czechoslovakia. There are scattered fields in southern France, Spain, Rumania, and several other countries. Russia has large fields in the southwestern parts of the country and others scattered through the south.

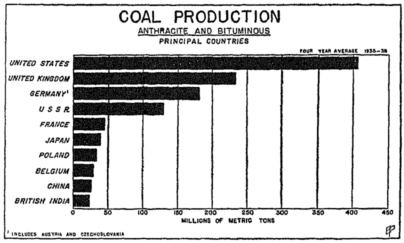


Figure 176 Most but not all of the leading industrial nations are listed among the leading coal producers. Italy, Sweden, Canada and Switzerland use hydroelectric power to supplement imported coal

German production is much less important now than prior to the World War, after which she lost a portion of the Silesian fields and control over the Saar Basin coal. The greater portion of the German production is concentrated in the Ruhr district and in Westphalia. Besides the large reserves of coking coal in the Ruhr, Germany has great quantities of lignite which is important as a fuel supply and as a source of petroleum products through hydrogenation. Coal is extremely important to the United Kingdom both as a source of fuel and as a product for export. Because of her large population and the lack of other fuels it is vital to her economic existence. In Russia, coal production is increasing rapidly due to the more stable government, the expansion of her industries, and the development of better and more adequate transportation facilities.

Other Centers of Production. In the other continents only China, Japan, India, and the Union of South Africa are important. Of these, Japan is the only industrialized nation and it leads the other Asiatic countries in coal production, although its reserves are small and mining is expensive. China is thought to have reserves second only to those of the United States, but production is small, although increasing. There is relatively little market in the country itself because of the small degree of industrialization, because much of the coal is located in the interior where transportation is poor or nonexistent, and political instability has done much to discourage development. The heaviest production occurs, not in

the areas of greatest reserves, several hundred miles from the coast, but in the smaller fields on the shores of the Gulf of Pohai in northern China. The navigable rivers of southern China also encourage mining in scattered fields along their courses. The coal fields of southern Manchukuo are one of the principal reasons for the interest of Japan in that country.

Coal in World Trade. Normally, only a small proportion of the coal mined enters into world trade. Coal is heavy and bulky in proportion to its value, and consequently can bear long-distance transportation costs only under the most favorable circumstances. Most export coal moves by water, the cheapest form of transportation. If land transportation is necessary the distances covered are usually short.

The United Kingdom has long been the world's coal exporter, and prior to the World War sent abroad approximately one-third of its total production. Its leadership in this field has been due to the possession of almost ideal conditions for the export of this product. The great majority of British coal is mined within twenty-five miles of the coast so that land-transportation costs are low. Ships bringing bulky raw materials to Britain would frequently have to depart half empty if it were not for coal, so they are willing to transport it at a low cost. Also, Britain's large merchant marine and numerous coaling stations formerly created a constant demand for British high-grade steaming coal throughout the world.

No other nation possesses the advantages of Great Britain and, as a consequence, none approaches it as an exporter. Germany normally ranks second. Most of its exports move by rail or inland waterway to neighboring countries. Poland and Russia are other European coal exporters. The United States normally exports between 3 and 6 per cent of the total coal produced, most of which goes to Canada. An important amount of this is Pennsylvania anthracite. used for domestic heating purposes.

Within recent years there has been a decided drop in the coal exports of all major countries. The most important cause has been the exploitation of small local coal deposits in those areas which formerly served as markets. Another cause has been an increase in the use of substitute fuels. This has been especially noticeable in the world's shipping; at present more than 40 per cent of the total tonnage uses oil for fuel as compared with 3.4 per cent in 1913 Greater efficiency in the use of coal has also decreased the demand for it in many markets. For example, fuel efficiency has been increased more than 10 per cent in Germany since 1913.

QUESTIONS FOR DISCUSSION

1. In what ways does English coal aid the English textile manufacturer?
2. What factors account for differences in coal production among regions having comparable reserves?
3. What advantages does oil have compared with coal for steamships?

The Future of Coal

The coal reserves are sufficient for thousands of years at the present rate of production. Furthermore, the leading industrial nations either have large supplies of their own or are able to get coal so cheaply from abroad that it does not pay to take expensive conservation steps if their own supplies are small or poor in quality. In fact, all of the principal coal-producing nations have excess capacities for production, and the coal industry is trying to maintain its hold on its markets rather than taking steps to conserve the supply. Only a few nations, including recently industrialized ones—such as Russia—are trying to expand production.

The stagnation of the coal industry is due largely to three factors: (1) overcapacity, (2) competition from other sources of energy, (3) increasing fuel efficiency. The last two, at least, are doing more to conserve coal for the future than all attempts to curb wastes and losses in production could possibly do.

Overcapacity. There are too many producing mines and too many miners in most of the important producing countries. This is partly due to decreased consumption brought about by the competition from other sources of energy and increased fuel efficiency, but some of it is due to other factors.

Among the important of the latter is the growing nationalism which is encouraging many countries to produce from their own small or high-cost deposits rather than to import. To some extent, this is due to the shift of coal fields from one country to another after the World War. This interfered with the former flow of trade, cut off markets formerly enjoyed by one district, and encouraged production in others. Elsewhere, the postwar depression forced some countries to produce at home or otherwise shift their sources of supply because they were unable to export to pay for imports.

A cause which operates in the United States, especially, is the uneven seasonal distribution of demand. While railroads and large industrial concerns attempt to buy their coal in large quantities and at the best prices, thus tending to even out seasonal inequalities, the small domestic consumer usually

buys as he needs coal for heating purposes—that is, during the colder months. Often he has very small storage capacity incapable of holding a year's supply. Since the mines and coalyards also lack adequate storage facilities, there must be a large number of mines to meet this peak demand, and many of them must, therefore, at other times, remain idle or operate at a low rate of production. This factor is especially important in the anthracite industry which finds most of its market among domestic consumers.

Other important causes of overcapacity are the improvements in equipment and mechanization of the mines, which give added production, and the stoppages due to strikes or other causes, which bring new mines into production in regions not affected. Disputes between management and labor in the anthracite fields have undoubtedly helped to shift consumers in northeastern United States and Canada to other sources of heat which they hope will be more dependable in supply and, hence, more stable in price.

Competition from Other Sources of Energy. This is probably the most important single reason for the distress in the coal industry. There was a small gain in total world consumption from 1913 to 1929, when the depression began to make itself felt most heavily. Over the same period the proportion of the world's total-energy supply which was derived from coal declined from 88 per cent to 72 per cent. While the increasing development of water power—especially in France, Italy, and Japan—and the increasing use of natural gas in the United States account for some of this displacement of coal, the growing use of petroleum was the major factor.

Petroleum has several advantages over coal:

1. It has been produced in increasing quantities and its price has, accordingly, been decreasing.
2. It is easier and cheaper to transport than coal because it is a liquid.
3. It has smaller bulk in proportion to its fuel value. This has been a major consideration in causing the wholesale shift to petroleum as a marine fuel
4. It is much better adapted to vehicles than coal.
5. For domestic purposes, it is fired automatically, is clean, and leaves no ash

Increasing Fuel Economy. This factor is almost as important as the substitution of other sources of power in causing a relative decline in coal consumption. The electrical utilities companies with their huge plants burning coal to generate electricity have been among the pioneers in this development. In the United States in 1902, it required 6 6 pounds of coal to generate one kilowatt-hour of electricity; in 1919, 3 2 pounds, by 1930 the consumption had fallen to 1 62 pounds, and the most efficient plants were using but .86 pounds. It has been estimated that if the output in 1930 had been produced at the rate of fuel efficiency prevailing in 1919, it would have required 49,000,000 tons of coal more than was actually used Similar increases in efficiency have occurred in other countries.

There has been a growing tendency for industrial plants to buy their power from the large utilities and for the railroads to electrify. Both of these tendencies have made for great savings in fuel because the coal has been burned in the efficient, large-scale installations, rather than in small and inefficient ones. Even in the moderate-size steam installations, increased efficiency of furnace and boiler equipment has resulted in large savings.

Coal as a Raw Material. The world has so long regarded coal as a fuel that most people neglect the significance of its recent use as an industrial raw material. The development of the by-product coke oven in the latter half of the last century has permitted the recovery of numerous by-products which can serve as raw materials for the chemical industry. Ammonia and tar are the most important of these derivatives. Ammonia is used principally in the manufacture of fertilizers and numerous chemicals. Tar is used directly in road building and waterproofing but is even more important as an industrial fuel and as a source of creosote, naphtha, numerous oils, dyes, medicines, and other chemicals.

It is becoming increasingly profitable to put the coal first through the by-product coke oven to recover the gas chemicals and use the coke as a fuel rather than use the coal in its raw state. Today some 20 per cent of all the coal used in the United States is treated in this way. Germany has made the greatest progress in this direction, and now less than 40 per cent of all German coal is consumed in its raw state. The remainder reaches the consumer in the form of coke, briquets, powdered fuel, gas, electrical current, oil, or gasoline. It seems probable that in the future most of the coal mined will be treated for the recovery of by-products before being used as a fuel.

QUESTIONS FOR DISCUSSION

1. Can oil replace coal for all uses? Can coal replace oil? Can hydroelectric power replace both?
2. Do you think that all of the world's coal will eventually be burned?

CHAPTER 29

IRON AND THE FERRO-ALLOYS

When men passed from stone and bones to metal as the material for their tools and weapons, they made great strides toward a higher civilization. Most of the commoner metals are easy to shape, are hard and strong, and are relatively easy to keep sharp. Tools made from metals enabled man to conquer the forest, build better boats and shelters, assure himself of a fuel supply, and bring more land under cultivation. Weapons made from metals increased his powers of offense and defense as well as improved his hunting. The next great forward step came with the application of power to the world's work. Here, the development of the mineral fuels and the metals had to proceed hand in hand Mining required good tools and power, and the application of power required metals for boilers, machinery, and the tools to make them. The application of power and metals to transport has almost conquered distance and thus transformed the use of the earth's surface.

The development of electricity was possible only because of the magnetic qualities of iron; its transmission was possible largely because of the unusual conductivity of copper, and some other metals, and the use of electricity for power was possible only through metal machinery. Obviously, life in the modern industrial and commercial nations would be vastly different, perhaps even impossible, without metals.

The Occurrence of Metals. The various metals are widely distributed throughout the materials of the earth, but they may be extracted profitably only where they make up a considerable portion of the rock material. Such concentrations of metallic elements may occur when the rock is being deposited. In igneous rocks like elements tend to gather together in the molten mass and are often found associated when cooling has finished. In sedimentary rocks there is apparently less tendency toward concentration during formation, although it does occur, either due to the sorting of materials according to their weights or through chemical precipitation. Deposits of minerals formed with the rock are known as *primary deposits.* Of perhaps greater significance in accounting for mineral concentration in easily accessible deposits near the earth's surface is deposition by underground waters. In waters arising from the hot materials of the earth's interior, mineral elements are carried upward in solution and deposited where pressure and temperature decrease until the carrying power of the liquid is lowered and deposition results. Elsewhere circulating water from the surface carries mineral elements downward in solution and deposits them when they come into contact with chemical minerals which precipitate them. Surface streams also erode mineral-bearing rocks and carry their minerals along in suspension. In such a condition, there is a sorting of the materials according to their gravities, and in this way a concentration of innumerable small particles derived from a wide area may come about. Paying deposits of gold, tin, or platinum are, thus, often found in stream gravels. Such stream-gravel deposits are called *placer deposits.*

Ores and Ore Bodies. *Ore* is rock containing large enough proportions of valuable minerals so that it is profitable to mine. An *ore body* or *ore deposit* is a large amount of such rock. This definition involves both geological and cultural variables. There must not only be considerable metal present, but it must be profitable to mine it with the technology and at the price prevailing. Thus, what is useless rock in one generation may become ore in the next, either because the price of the metal has risen or because some technique has been developed which will enable it to be mined more cheaply. Copper was one of the earliest metals used by man because it is sometimes found in chunks of almost pure metal. Then, methods of smelting developed which enabled rock containing smaller percentages to be mined profitably. They thus became *ores.* The improvements in methods of mining and refining continued until now rock containing as little as 1½ per cent of copper by weight can be mined profitably and is considered ore. Thus a mineral deposit that is ore in one coun-

METALS AND THEIR ORES	UNITED STATES				GERMANY				FRANCE				U. KINGDOM				JAPAN				BELGIUM				ITALY				SPAIN				METALS AND THEIR ORES
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	
ALUMINUM		●						●	●							●				●				●	●							●	ALUMINUM
ANTIMONY				●				●			●					●				●				●			●			●			ANTIMONY
CHROMITE				●				●				●				●			●					●				●				●	CHROMITE
COPPER		●					●					●				●		●						●				●	●				COPPER
IRON		●					●		●					●					●				●			●			●				IRON
LEAD		●					●					●			●					●				●		●			●				LEAD
MANGANESE				●				●				●				●			●					●				●	●				MANGANESE
MERCURY			●					●				●				●				●				●	●				●				MERCURY
NICKEL				●				●				●				●				●				●				●				●	NICKEL
TIN				●				●				●			●					●				●				●				●	TIN
TUNGSTEN		●						●				●				●				●				●				●		●			TUNGSTEN
ZINC		●						●				●				●		●						●	●				●				ZINC
NON-METALS																																	NON-METALS
ASBESTOS				●				●			●					●				●				●			●					●	ASBESTOS
BARITE			●		●						●				●					●			●		●					●			BARITE
CHINA CLAY			●				●				●		●					●						●				●			●		CHINA CLAY
COAL	●				●						●		●						●				●					●			●		COAL
FLUORSPAR			●		●						●		●						●					●		●				●			FLUORSPAR
GRAPHITE			●				●					●				●	●							●	●					●			GRAPHITE
GYPSUM		●			●				●						●			●						●		●				●			GYPSUM
MAGNESITE			●					●			●					●				●				●			●				●		MAGNESITE
MICA			●				●					●				●		●						●				●				●	MICA
NITRATES				●	●							●				●				●				●				●				●	NITRATES
PETROLEUM			●					●				●				●			●					●				●				●	PETROLEUM
PHOSPHATES	●							●			●					●			●				●					●				●	PHOSPHATES
POTASH				●	●				●							●				●				●		●					●		POTASH
PYRITES			●					●			●					●		●						●		●			●				PYRITES
SULPHUR	●							●				●				●	●							●	●						●		SULPHUR
TALC AND SOAPSTONE		●					●		●							●			●					●	●					●			TALC AND SOAPSTONE

Figure 177 Ability of the principal consuming countries to supply their own needs of the principal industrial minerals from within their own boundaries. A.–Minerals available in large quantities for export, B–Minerals adequate to meet domestic demands without appreciable excess or deficiency, C–Partially dependent on foreign sources; D–Dependent almost entirely on foreign sources Table taken from *Mineral Raw Materials,* U S Department of Commerce, Washington, 1929

try may not be considered ore in another because, in the second country, labor is expensive, demand is small, or capital costly.

The Conservation of Minerals. Minerals are formed so slowly that for all practical purposes they are not replaceable; thus production and use result in a depletion of the supply available for the future. Even within the mineral group itself, there are, however, marked differences in the amount and degree of destruction which comes from use. The fuels–coal and petroleum–once burned are gone and there is no possibility of recovery. On the other hand, most of the metals are only partially destroyed by use, and a large percentage of the scrap is recoverable. In a great industrial nation this stock of scrap may eventually grow so great that there is a significant decline in the annual demand for new metal. The nonmetals are distributed between both of the above classes as to recoverability. The chemicals–such as sulphur and nitrates–once used become so changed in form that recovery is often unprofitable. In contrast, most building stones can be reused almost indefinitely. Such differences in fundamental properties prevent the making of many generalizations applicable to all minerals, and make necessary a new study of economic, social, and political problems for almost every mineral.

A policy or technique which would be ideal for one set of physical or social circumstances may well be anything but economical in another. A given quality of iron ore which in the United States is considered too poor to send to the blast furnace would be considered a valuable resource to the Japanese manufacturer, because iron ore is scarce in Japan and labor is cheap enough to warrant a more extended use of it on each unit of the resource. If petroleum is so plentiful in the United States that it does not pay to use a great deal of expensive labor and capital to

make sure that no single barrel of it is lost, the industry cannot necessarily be accused of "wastefulness." The opposite policy might conserve more of the resource, but it would be more wasteful of human effort and capital which have been, in the past, the more expensive agents of production. As changes occur in the relative values of the three agents of production, it may become profitable to alter the production policies. A change in techniques of exploitation or use, or a price increase which would make more conservative methods profitable, might bring about the same result.

Adequacy and Distribution. Minerals are by no means evenly distributed throughout the world and no modern industrial nation has within its borders cheap supplies of all of the required minerals. Figure 177 illustrates this very effectively. The widest variety and most adequate reserves of minerals are found in those countries bordering on the north Atlantic. The United States and Canada, especially, have large supplies of nearly all of the important industrial minerals with the exception of tin. Northwestern Europe has a wide variety of metals, is abundantly supplied with coal, and lacks only petroleum in large quantities. Asia and eastern Europe have metals and fuels in adequate quantities, but the deposits are, in many instances, so unevenly distributed and distances between them are so great that their significance has been lessened. With the exception of Australia, the continents of the Southern Hemisphere have entirely inadequate supplies of coal. Petroleum tends to make up for this deficit in South America, but Africa has almost none. Both of these continents are, however, rich in the metals.

It will be noted that the portions of the world which lead in industrial and commercial development are the ones with the most satisfactory mineral resources. The possession of minerals has undoubtedly helped to explain the direction of development in these regions, but is by no means the only reason for it. It will be noted that many individual nations—such as Great Britain, the Netherlands, Switzerland, Germany, and France—have developed manufacturing of many mineral products without having large supplies of both fuel and raw material within their borders. Apparently lack of supplies is not an absolute barrier to this type of development, and, on the other hand, predominantly agricultural countries—like Mexico, Peru, and China—are well stocked with minerals, so their presence does not, of necessity, lead to their use by the natives of a country. Most of the mineral development in any part of the world has come about at the hands of people from the borders of the North Atlantic.

Iron

Iron is among the commonest elements and considerable concentrations of it occur in nearly every nation. It has become the metal of greatest use and the basis of the whole modern industrial system, for not only is it common, but it can be easily and cheaply extracted from its ore. The magnetic properties of iron make it absolutely indispensable to the electrical industry, where it is an essential part of the dynamo, the motor, all electrical measuring instruments, the telephone, telegraph, and radio. By varying the process of manufacture or alloying it with small quantities of other metal it can be made hard or soft, brittle or tough, pliable or rigid. Probably 90 per cent of the world's iron is now used in the form of steel.

Iron Ores. There are only four important types of iron ore: *hematite* (red ore), *limonite* (brown ore), *magnetite* (black ore), and *siderite* (iron carbonate). Hematite, limonite, and siderite are *sedimentary* or *residual* ores; that is, they were either deposited as sediments at the time of the formation of the surrounding rock, or they represent deposits of iron left when other materials have been eroded or carried away in solution. Magnetite is a primary ore which is formed with igneous rock. It is usually considered the finest of the iron ores because of its high iron content and high magnetic qualities. Hematite is an iron oxide and one of the very good ores. Limonite (iron oxide combined with water) is usually lower in quality, and siderite is of great importance only in one large deposit (the Cleveland Hills of England).

Factors Affecting Exploitation. The smelting of iron ore and the manufacture of steel require so much fuel that iron deposits are seldom developed except in relation to a supply of coal. In general, those deposits of iron occurring near coal or where water transport to coal supplies is available are of greatest importance. In addition, because the ore is so bulky, large quantities which will justify the installation of heavy mining and shipping equipment must be present. The richness of the ore is also a decisive factor. In Europe much ore containing only 30 per cent iron is mined and used because better ore is not available. In the United States there is so much ore available which contains better than 50 per cent

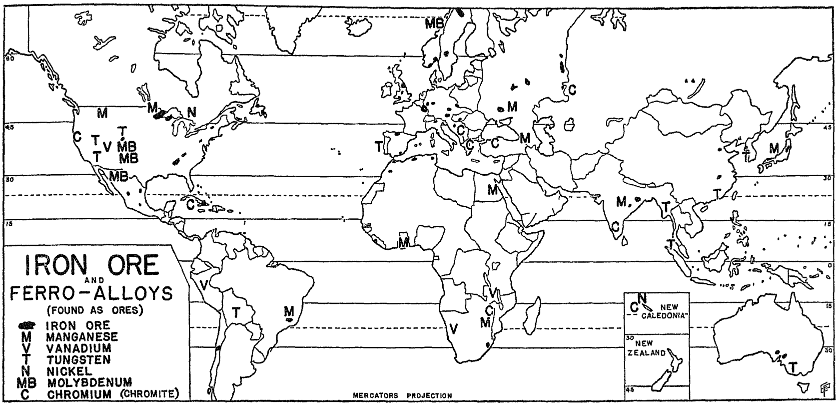


Figure 178.

of iron that most ores having a lower iron content are ignored, unless they have some other peculiarly advantageous quality such as being low in impurities. Often ores from several sources are mixed in the blast furnace in order to offset the impurities present in one of them. The nature of the deposit from a geologic standpoint also affects the probability of utilization. Where the ore lies near enough the surface that it may be cheaply mined by low-cost, open-cut methods, it may pay to exploit lower grade ore than that in deeply buried deposits requiring shafts and tunnels.

The iron and steel industry is seldom located very close to the sources of ore. Coal is used in such great quantities, both as a fuel and as a raw material, that there is a tendency for ore to travel toward the coal for smelting. This tendency is also increased because the markets—that is, the large industrial centers—are usually also closely related to the coal fields. All of this does not mean that the iron and steel plants are always located in a coal-mining region, but that they are usually located where coal and iron may be most cheaply brought together, always bearing in mind the relation to market. However, coal exerts a stronger pull on the location of the industry than does the ore.

Only six large industrial nations—United States, Germany, France, Great Britain, Belgium, and Russia—produce large quantities of steel and, thus, serve as a large market for iron ore. Although some twenty-seven countries mine iron ore, the six largest steel-producing nations named above and Sweden are the only large producers of ore. This shows strikingly the influence of the market and fuel factors, for good grades of iron in large deposits are much more widely available than this.

Scrap. Another source of raw material for the industry is steel scrap. Any large industrial nation has large actual or potential supplies of it available. In the steel furnaces in the United States approximately equal amounts of scrap and pig iron made from ore are used. Some of this scrap is the by-product of the industry itself in the form of waste, spoiled ingots, steel spilled in pouring, etc. The rest comes from discarded steel articles which have outlived their usefulness. The United States and Great Britain, "old" industrial nations, have excess supplies of scrap and export it to countries "new" in the industry or poor in iron ore.

Steel-making Processes. Iron ore is refined in the *blast furnace.* Ore, coke, and limestone are heated together in a tall furnace. The coke supplies fuel and the limestone fluxes with the impurities in the iron. Molten iron flows out at the bottom. It was formerly poured into molds which gave it a shape roughly resembling a dressed pig, and it is called *pig iron* on that account.

In most modern plants pig iron, before it can cool, is carried to steel furnaces where it is mixed with steel scrap and any alloys desired, and further

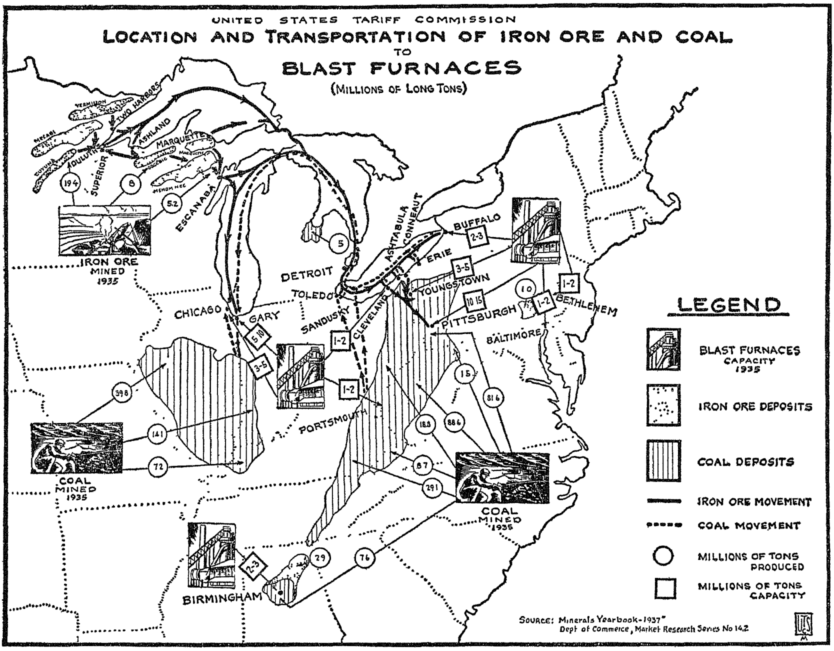


Figure 179 This map and Fig. 180 are from *Iron and Steel,* a valuable report of the United States Tariff Commission (Washington, 1938).

heated. A hot blast is passed back and forth over the molten mass until the carbon content has been reduced to the desired amount and other impurities removed. The product of such a furnace is steel which is superior to iron because of its greater strength and the many qualities which may be given it by the addition of the alloys.

Steel, too, is removed in a molten form and poured into giant molds. Here it cools into a mass sufficiently solid so that it can be handled by cranes, and then is taken to the *rolling mill* to be rolled into bars or billets. Bars and billets are often sold directly to other industries which produce a wide variety of steel products from them. Often, however, the large, completely integrated plant will take these bars or billets and further roll, forge, or press them into such articles as rails or sheets, or draw them out into the form of wire or tubing.

QUESTIONS FOR DISCUSSION

1. Use Fig. 177 as a basis for grading each of the great powers on the basis of self-sufficiency in mineral resources.
2. What does the location of Gary (pages 3-4) show about the importance of iron ore, coal, and markets as locating factors?
3. What will be (in your opinion) the principal sources of raw materials for the American iron industry in the year 2000? Explain.

Iron and Steel Industry of the United States

The United States is the leading producer and consumer of iron and steel products, accounting in recent years for about 40 per cent of the annual world output. This industry is second only to the automobile industry in size and importance. Because of the high standard of living in the United States, the

mechanization of its homes and farms, the size and nature of its industries, and its highly mechanized transport, there is a tremendous home market. Both coal and iron ore are abundant, excellent in quality, and favorably located with relation to each other and to the market.

A considerable change has come over the market for iron and steel products in recent years. When the nation was expanding, the railroads were the largest consumers and the building trades were next. Heavy articles such as rails, locomotives, cars, and structural shapes were in greatest demand. In 1937 the automotive industries were the leading consumers, railroads were second, metal containers a close third, and the building industry fourth. Automobiles and metal containers call largely for sheet steel and other light products. Increased industrial activity would undoubtedly be reflected in a marked increase in the demands of the railroad and building industries.

Iron and Steel Districts. The principal markets for the products of this industry lie north of the Ohio and Potomac rivers and east of the Mississippi. Within this market area iron and steel industries have grown up at places where iron ore and good coking coal could be most cheaply brought together. The location of the principal blast furnaces in the United States and the sources of their raw materials and fuel are shown in Fig. 179.

Figure 180 shows the capacity of these various districts to produce the major types of iron and steel products. The Pittsburgh and Youngstown districts between them produce about 40 per cent of the total. The Chicago-Gary district is second; the Cleveland and Eastern Pennsylvania-Maryland districts are almost tied for third place. The availability of scrap iron and steel either from the industry itself or from the wastes of the densely populated and highly industrialized northeastern part of the country is an increasingly important source of raw material.

Approximately 80 per cent of the iron ore mined in the United States comes from the high-grade hematite deposits of the Lake Superior region Rich ore bodies are scattered through the portions of the states of Minnesota, Wisconsin, and Michigan which lie about the western and southern shores of the lake and all are within a short haul of lake ports. The situation of these deposits with regard to the Great Lakes is especially important. Cheap lake transport in specially designed ships, and with specially designed loading and unloading equipment at both termini, carry ore down the lakes to ports such as

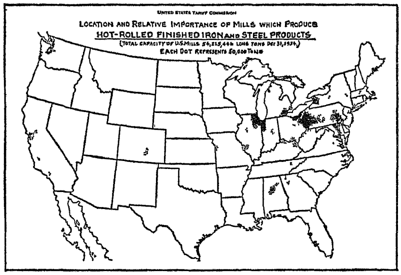


Figure 180.

Chicago, Gary, Detroit, Toledo, Cleveland, and Buffalo where easily accessible coal from the Appalachian or Illinois fields allows the ore to be manufactured in, or on the way to, the country's principal markets. In addition, it is shipped from such ports as Cleveland, Ashtabula, Conneaut, and Erie, inland to the steel centers of Youngstown, Pittsburgh, and Wheeling. The total reserves in the Lake Superior district make it one of the largest in the world, but the reserves of the highest grade are not inexhaustible,[1] and when these are gone, the American iron and steel industry will have to adjust itself to lower grade ores.

Early in the last century when the iron industry was small, the scattered ore deposits of the eastern parts of the country were of considerable importance. Now, they are used only for small local iron centers. The magnetite deposits of Cornwall, in southeastern Pennsylvania, of the district about Mineville, in the Adirondack Mountains in New York, and of Essex County, New Jersey, are used for mixing with other ores in Eastern blast furnaces. Hematite of appropriate richness for profitable mining exists in the South, notably about Chattanooga, Tennessee, and Birmingham, Alabama. In the latter place, it lies near the surface, is cheaply mined, and occurs within a few miles of large deposits of coal and limestone. This combination of favorable raw materials and fuel gives rise to the largest iron and steel center in the South. Small amounts of iron ore for consumption in local blast furnaces are also mined in Minnesota, New Mexico, Utah, and Wyoming.

Iron Ore in American Foreign Trade. In spite of its tremendous production and reserves of ore, the

[1] Some students of the region estimate that if the present rate of consumption continues, the high-grade Lake Superior ores will be exhausted in from thirty to fifty years.

United States is both an exporter and importer of iron ore. Lake Superior ore is exported to furnaces in the province of Ontario, Canada, because of cheap water transport via the Great Lakes. Furnaces on or near the eastern seaboard, such as those at Sparrows Point, Maryland, and in eastern Pennsylvania, supplement local ores with imports from abroad, chiefly from Chile and Cuba This import is small as measured against the total consumption of ore in the United States, but it is significant that blast furnaces on the eastern coast which obtain coal cheaply from the Appalachian field find it cheaper to bring ore all the way by water from Chile than to bring it by lakes and rail from the Lake Superior deposits.

Canada and Newfoundland. Reserves of iron in various parts of Canada are tremendous, but the only areas of important exploitation are in Nova Scotia. On the south coast of Newfoundland there are very large reserves of high-grade hematite which are used to some extent in blast furnaces at Sydney, near the small coal fields of Nova Scotia. This is the only large iron deposit on the North American continent which is on the seacoast. Some is therefore exported to the United States at times.

The Eurasian Iron and Steel Industries

The outstanding deposit of iron ore in Europe is the great Lorraine field which underlies parts of Belgium, Luxemburg, France, and Germany. This ore is a sedimentary limonite with an iron content of 25 to 45 per cent. The coking coals of the Ruhr Valley and the Saar Basin (both in Germany), together with short rail distances and cheap barge transport on a wide network of rivers and canals, are the principal physical bases for the great iron and steel industries of this district. In addition, it lies in the heart of one of the most important consuming markets of the world. Although the actual area covered by this iron and steel district is small, it is split up by international boundaries so that France and Luxemburg are poor in coal and Germany and Belgium are poor in iron ore. This results in a tremendous international trade in both products, although few of the raw-material shipments move more than one hundred and fifty miles.

Germany and Austria. At the outbreak of war in September 1939 Germany was the world's second largest producer of iron and steel products and the leading exporter—despite the fact that about 70 per cent

Figure 181

IRON ORE AND PIG IRON PRODUCTION AND IRON ORE RESERVES OF PRINCIPAL COUNTRIES

Country	*Iron ore production (Thousands of metric tons)*			*Pig iron production (Thousands of metric tons)*			*Estimated iron ore reserves (Millions of metric tons)*
	1929	*1932*	*1938*	*1929*	*1932*	*1938*	
United States	74,200	10,005	28,904	43,298	8,921	19,475	4,700
France	50,731	27,559	33,137	10,362	5,550	6,049	1,790
United Kingdom	13,427	7,446	12,050	7,711	3,630	6,872	317
Sweden	11,468	3,299	14,953 *	524	282	663	442
U S S R.	7,988	12,063	27,000	4,320	5,000	15,180	260
Luxemburg	7,571	3,213	5,049	2,906	1,959	1,551	(b)
Spain	6,559	1,760	2,513	753	303	200	353
Germany	6,191	1,319	10,939	15,344	5,282 (2)	18,207 (2)	255
Czechoslovakia	1,808	602	1,836 *	1,645	450	1,234	(b)
China (Inc. Manchukuo)	2,426	2,233	2,545 *	444	300	600	?
India (British)	2,468	1,789	2,885	1,418	928	1,560	300
Algeria	2,196	467	3,105	(a)	(a)	(a)	. . .
Austria	1,891	307	2,647	459	94	389 *	76
Chile	1,812	173	1,608	(a)	(a)	(a)	1,000
Newfoundland	1,541	151	1,707	(a)	(a)	(a)	4,500
Belgium	156	93	265 *	4,041	2,783	2,465	(b)
Japan	178	227	754 *	1,112	1,542	3,000	. . .
Canada	(a)	(a)	(a)	1,188	162	771	. . .
Cuba	682 (1)	83 (1)	155 (1)	(a)	(a)	(a)	1,000

(a) Negligible. (b) Included in "other European reserves of 150,000,000 tons"
* 1937.
(1) Shipments (2) Includes the Saar.

of its iron ore had to be imported, largely from Sweden and the Lorraine field in France. Until 1936 Spain was also an important source of supply, but war in that country brought its exports practically to a standstill.

German ore deposits are scattered and poor in quality. The principal German iron and steel districts adjoin the principal coal fields. The Ruhr Valley vicinity is outstanding, producing about 70 per cent of the country's total output. Ruhr coal is plentiful and excellent for coking. The Saar Basin, close to the Lorraine iron ore field, is a small coal producer and the second iron and steel region in rank. There are other scattered steel districts, the most important of which is the German portion of the Upper Silesian coal field. With German domination of Poland and Bohemia, this whole Silesian field may assume a new importance. However, the inclusion of Austria and Bohemia within the Reich will probably add to German production of steel less than three million tons, which is less than one-sixth of total German steel production in 1937.

Technically German industry is developed to a very high point and is highly organized for the production of a variety of specialties such as sheet steel, wire, and wrought iron pipe for export to neighboring countries to pay for imports of iron ore.

France. Most of the great Lorraine iron ore field lies in this country. It is, therefore, second only to the United States as an ore producer and ranks first as an ore exporter. It is, however, fifth in production of iron and steel manufactures.

The principal steel district of France is along the eastern border in and near the Lorraine ore fields. Coal is present in considerable quantities but is of poor quality for steel-making purposes. Therefore coke must be imported, normally from Germany, and the general rule that manufacture tends to spring up near the location of coking coal rather than iron ore is thus belied. The desire of the French to have an important iron and steel industry of their own leads them to import coke where necessary. Actually, although this coke must be "imported," it is brought a relatively short distance.

The other important steel district lies near the coal fields at the extreme northern tip of France, near the Belgian border and near the English Channel. Ore from Lorraine or Spain or Sweden and scrap, which is available in large quantities in the important industrial district of which this is a part, are the raw materials.

Belgium-Luxemburg. These two countries have been joined in an economic union since 1922. This union, although small in area, stands sixth among the world's steel producers and was the leading exporter of finished and semi-finished iron and steel products in 1937. Since Belgium has only a small amount of coking coal and iron ore and Luxemburg small ore reserves within its borders, the bulk of the raw material and fuel is imported. In peace times at least this is less of a handicap than it at first appears, since the coking coal of the Ruhr district and the Lorraine iron ore fields are within a few miles of the principal steel districts and may be reached, at least in part, by cheap canal transport.

The production of iron and steel is centered around Liége and Charleroi in the Sambre-Meuse Valley. This is Belgium's principal coal field and its leading heavy industrial district. To it river, canal, and railroad bring ore and coke, and from it the same transport agencies carry exports cheaply to near-by Netherlands and Germany or to the ports for overseas shipment to Great Britain (the principal foreign market) and to Argentina, Sweden, China, and the United States which also take important amounts. The ability of Belgium to compete in such markets as Great Britain, Germany, and the United States, each of which has its own steel industry, is due to several factors: the Belgian steel industry had to be entirely rebuilt after the destruction caused by the World War and is therefore new and efficient; costs of assembly of fuel and raw material are low due to position and cheap water transport, labor costs are low due to the high skill of the population and to the fact that the industrial worker is also often a part-time farmer. In addition, the Belgium-Luxemburg industry has specialized in certain products, such as wire and sheets, which find a ready sale abroad.

The United Kingdom. Here the modern iron and steel industry received its start, but due to the rise of markets and industrialization elsewhere, the discovery of resources in other countries, and the imposition of trade barriers this country is now in fourth place among the nations of the world Coal, both for power and for coke, is abundant and much of it is conveniently located at tidewater. In recent years about two-thirds of the iron ore used has been supplied by domestic sources. Most of this ore comes from well-distributed mines scattered through the eastern and southern interior of the island. The remainder is mined north of Liverpool and about Glasgow on the west coast. Scrap is a very important source of raw

material in this old industrial country. The imported ore comes mostly from Spain, Sweden, and North Africa. The Birmingham district, the Lowlands of Scotland, and the Newcastle district are the principal iron and steel manufacturing regions.

The British industry is diversified and produces goods of high quality. It lagged for some years following the World War, but in recent years has progressed and expanded rapidly. Its exports tend to be more largely in the form of machinery and finished goods than in raw materials for further manufacture.

U.S.S.R. This vast nation, relatively new in the ranks of industrial countries, now holds third place in the production of iron and steel. Since the revolution of 1917 every attempt has been made to make the country self-sufficient in all lines and especially in this basic industry. Because equipment is virtually all new, it is of the latest pattern and capable of a high degree of efficiency.

The ore reserves of the U.S.S.R. are large and high in iron content, but, in some instances, poorly located with regard to markets and coal. The Krivoj Rog ores are in the south near the Donetz coal fields and the large industrial district there. The lower-grade ores in the Moscow district, where coal is poorer but access to markets is excellent, are perhaps the best located. The large ore reserves of the Urals give rise at Magnitogorsk to a large industry which brings coal from the Kuznetsk Basin, 1400 miles away by rail. In turn, the Kuznetsk industry depends largely on Ural ore. Russia, with her great distances and lack of inland waterways running in the right directions, moves coal and iron farther by rail than any other country. Nearly three-fifths of Soviet production is accounted for by the Ukrainian district, one-fourth by the Kuznetsk-Ural districts, and about one-twelfth by the Moscow area. At the outbreak of the European war in 1939 there was still a considerable import of sheet steel, bars, tin plate, and pipe.

Japan. Japan, including her dependencies on the mainland of Asia, is now the ranking producer of iron and steel in the Orient and the sixth in world production. With little iron ore in the islands, she has depended on imports of pig iron from Manchukuo and India, and scrap, largely from the United States, for a considerable portion of her raw material. She has also been forced to import some of her coking coal. Japan imports considerable quantities of finished steel products from the United States and other countries, and exports simpler products, mainly to China and the East Indies.

QUESTIONS FOR DISCUSSION

1. Why does the Ruhr district of Germany import so much iron ore from Sweden when the French fields in Lorraine are much nearer?
2. Small iron and steel industries are found in many countries which are poorly supplied with iron ore and coking coal How may this be explained?
3. Outline the environmental problems which had to be solved in developing the Russian steel industry.

International Trade

Iron Ore. France and Sweden supplied about two-thirds of world exports of iron ore in recent normal times. France's position is explained by her ownership of most of the great Lorraine fields and the fact that iron-hungry Germany and Belgium-Luxemburg lie at her doors Sweden has large reserves of high-grade iron, practically no coal, and exports to near-by Germany and England, which have coal and can be reached by cheap water hauls Until recently Spain was an important exporter to Britain and Germany from mines in the southeastern part of the peninsula, but the Spanish Civil War and the ensuing European War have disrupted that trade North Africa—both French and Spanish—British Malaya, China, Chile, and Cuba are minor exporters. None of these are important industrial countries, nor have they significant iron and steel industries of their own. Brazil has very large ore reserves of high quality, but their location in the interior plus lack of cheap transport have retarded their use.

Iron and Steel Products. Much of the trade in the products of the iron and steel industry is concealed in the statistics of the trade in articles of which iron and steel make up a part. The United States, for instance, is a large exporter of automobiles much of the value of which is steel, but it is not counted as steel in export statistics. The principal articles usually included in the statistics are steel billets, bars, wire, plates, structural shapes, rails, and iron pipe. In tonnage of products exported Germany, Belgium-Luxemburg, the United Kingdom, France, and the United States in normal years usually ranked in the order named However, the exports of Germany, the United Kingdom, and the United States were usually of high value, while those of Belgium-Luxemburg and France were of low value intended for further fabrication abroad.

In addition to being important exporters, the United Kingdom and Germany are also important importers, the former having been the larger during recent years. The imports of each have been either

Figure 182 [1]

PRINCIPAL NON-FERROUS METALS USED BY STEEL INDUSTRY

Metal	*Reason for use*	*Typical applications*	*% of World production produced in U S in recent years*	*% of World production consumed in U S. in recent years*	*Chief sources of United States supply*
Aluminum	Removes gases and impurities	Seldom more than a trace remains in the steel	30	40	United States
Chromium	Small amounts improve hardening qualities; more than 10% prevents rust	Tools, machinery parts; stainless and heat- and acid-resisting steels	Insignificant	40	Africa, Cuba, Greece, New Caledonia
Cobalt	Holds cutting edge at high temperatures Improves electrical qualities	High-speed cutting tools, permanent magnet steel	None	10	Canada, Belgian Africa, Australia
Copper	Retards rust	Roofing and siding sheets	40	35	United States
Lead	When mixed with tin, forms a rust-resisting coating for steel. Small amounts alloyed with steel improve machinability	Sheet steel for roofing, auto gasoline tanks, etc , machinery parts	30	35	United States
Manganese	Small amounts remove gases from steel, 1 to 2% increases strength and toughness, 12% imparts great toughness and resistance to abrasion	Small amounts present in all steels; 1 to 2% used in rails, 12% or more for frogs and switches and dredge bucket teeth	Insignificant	20	Russia, Gold Coast, Brazil, India
Molybdenum	Increases strength, ductility, and resistance to shock	Tools, machinery parts; tubing for air-plane fuselage	80	30	United States
Nickel	Increases toughness, stiffness, strength, and ductility In large amounts resists heat and acids	Tools, machinery parts; stainless steels; heat- and acid-resisting steels	Insignificant	50	Canada, Norway, New Caledonia
Tin	Forms corrosion-resisting coating on steel	Sanitary cans; kitchenware	Insignificant	45	British Malaya, Netherlands India, Bolivia
Tungsten	Retains hardness and toughness at high temperature	High-speed cutting tools; magnets	10	20	China, British Malaya, United States
Vanadium	Increases strength, ductility, and resiliency	Tools, springs; machinery parts	15	25	United States, Peru, Rhodesia
Zinc	Forms corrosion-resisting coating on steel	Galvanized roofing and siding sheets; wire fence; pails, etc.	35	35	United States

[1] From *Steel Facts*, November, 1938.

special steels or semi-finished, low-cost materials—often from Belgium—for further manufacture. Japan, the Netherlands, and Canada, important countries with few or poorly located iron or coal resources, are the other leading importers.

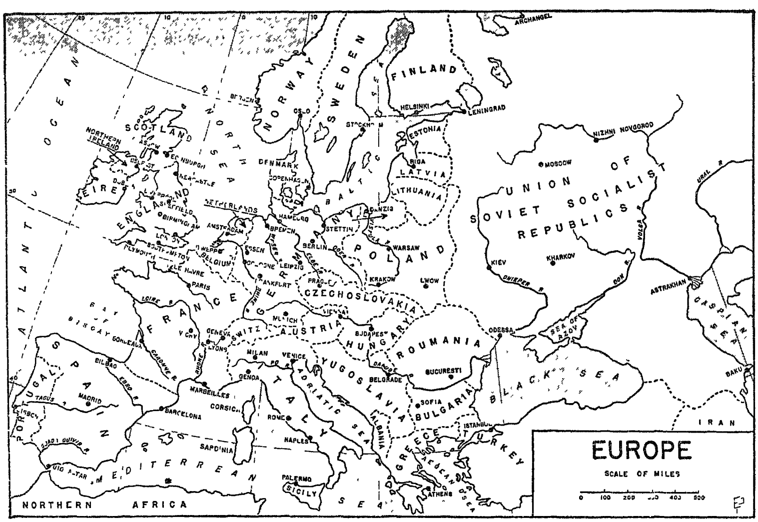
The Ferro-alloys

This important group of metals is of significance far beyond that indicated by the small world annual consumption. Each, when alloyed with steel, imparts some special quality which is of vital significance. Figure 182 lists these metals, the qualities imparted to steel by each, and the principal source of the metal for the American industry. No modern industrial nation is an important producer of any number of them and some of the most important steel-producing nations produce none of them. This has very large significance from a military standpoint and is disturbing the military and naval staffs of the great powers. Some of this condition is due not to the entire absence of deposits of these metals within the borders of industrial countries, but to the low quality of the deposits. The United States, for example, has large deposits of manganese and chromite but depends largely on imports because many of these deposits are either scattered or too low in metallic content to be worked under normal conditions.

Even in alloys there is a scrap situation. While it is very difficult to separate the alloy from steel scrap, economically, it is becoming increasingly common for companies selling special alloy steels to make the return of foundry scrap or machine shop cuttings and shavings a condition of the sale. This makes it possible to use them over again for making steel of the same specifications.

QUESTIONS FOR DISCUSSION

1. What changes in the trade in iron ore and iron products are likely during a period of European war?
2. Are the ferro-alloys considered as contraband of war. Why?
3. Why do countries, such as the United States, which have adequate reserves of iron ore, often import iron ore?



The boundaries shown are those at the beginning of 1938 By August, 1941, Austria, western Czechoslovakia, western Poland, and Alsace-Lorraine had been annexed to Germany and in addition Norway, Denmark, the Netherlands, Belgium, Luxemburg, Slovakia, Hungary, Yugoslavia, Albania, Greece, Bulgaria, Roumania, eastern Poland, Lithuania, Latvia, and Estonia have been placed under German military control.

CHAPTER 30

NON-FERROUS METALS

WHILE iron and steel have supplied the largest single metallic bases for the present industrial civilization, non-ferrous metals are, in the aggregate, only slightly less significant. Some of them, such as tin and zinc, find their main uses in connection with iron and steel as protective coatings. Others, such as copper and lead, owe their major consumption to the electrification of the industrial world which has done so much to increase man's productivity and comfort. Again, copper and aluminum, besides uses of their own, are alloyed with steel to give it special qualities.

Copper

As a raw material copper has contributed much to human history. Alloyed with tin to form bronze, it enabled man to make some of his mightiest strides toward civilization. Although later it took a secondary place to iron when that metal was found to be even better for weapons and tools, it has been used increasingly down through the years as roofing material, material for utensils, sheathing for ships, etc., and in the alloy brass. But it was not until the application of electricity to industry that copper really came into its own and assumed a place that is second only to iron in importance among the metals. More than half of the consumption of copper in the United States is due to its use as a conductor of electricity.

Copper Ores. Copper occurs very widely in nature, and workable copper deposits are much more widespread than valuable deposits of iron ore. The mode of occurrence of copper deposits is extremely varied, and the causes of many deposits are still moot geological problems. Copper is seldom the sole metal found in the ore. Some or all of the other metals may be found in the same ore body. In one ore body the associated metals may appear in such form and quantity as to make their recovery quite profitable, in another they may merely complicate the refining of the ore. From a geographic standpoint, it is necessary to mention only two broad types of occurrence. that in which the copper occurs with other metals in definite veins or pockets, and that in which the copper is disseminated throughout a wide zone in the rock In the latter type the copper content is often low.

New Techniques. The copper-mining industry is an excellent example of the way in which changing technology brings new rock into the class of ore. When hand-mining methods and crude smelting were in vogue, it was necessary to restrict activity to veins or pockets which would yield pieces of rock high in copper Rock had to be carefully selected and only the richest could be profitably brought to the surface and smelted. As a result, much of the copper in any deposit was not mined. In addition to the ores occurring in veins, miners were constantly encountering great quantities of rock of very low copper content. The total amount of copper in such deposits was often greater than in the "rich" veins, but enormous masses of rock would have to be handled to recover it. There was not only the problem of the cost of the physical mining and transporting of this low-grade rock, but it was also unprofitable to handle in the smelters.

The problem of low-cost handling of the rock was solved by applying machinery to every possible operation. In many of the largest ore bodies the covering rock was removed and the ore mined by huge steam shovels, it was then loaded on railroad cars running over temporary roadbeds, and the cars were unloaded at the concentrating mill by lifting them up and turning them over.

The concentrating mill increased the copper content of the ore so that it could be profitably handled in the smelter. In the concentrating mill the ore is ground very fine and then washed over a series of moving grids. The rock particles with a high copper content are heavier than those containing little or no copper and are therefore left behind when the other rock is washed away. The copper content of this *concentrate* is now high enough so that it may be smelted profitably. The *middlings,* or refuse from this process, may still contain considerable amounts of copper in tiny particles. These middlings are often ground into a fine powder, mixed with water and oil, and the

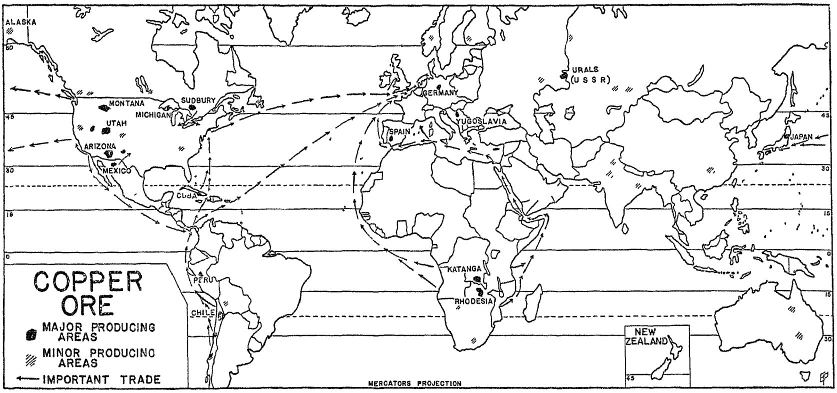


Figure 183 Copper deposits occur in ancient crystalline rocks and in mountainous regions with igneous intrusions.

whole mass stirred by huge machines. Particles of copper cling to the oil particles, and when the oil floats to the top of the mixture and is drawn off, practically all of the copper in the ore goes with it. This is known as the *flotation process,* for obvious reasons. The concentrate is then separated from the oil, dried, and sent to the smelter. Concentration and the flotation process have been applied to the ores of many metals and have greatly increased the efficiency of recovery.

All of these improvements in technique have put rock containing less than 1½ per cent of copper into the class of ore if it is present in large enough deposits to warrant the investment in handling machinery and concentrating mill. In fact, the average copper content of ores mined in the United States between 1927 and 1929 was as low as 1 41 per cent.

The Distribution of Smelters and Refineries. Because of the bulk of the ore and the relatively small amount of copper in it, even after concentration, it is usually smelted at some central place in the mining district where the necessary supplies of coke and limestone are available. The product which is shipped from the smelting center is *blister* copper (99.3 per cent pure). For electrical uses, copper must be almost absolutely pure, so these blocks are usually refined electrolytically to a purity of 99 92 to 99.97 per cent before being marketed. The electrolytic refining is usually carried on somewhere between the smelters and the market. It requires tremendous supplies of cheap electric power, and cheap coal or large hydroelectric developments are favorable locating factors The United States refines large quantities of imported blister copper, much of it being done on the Atlantic seaboard. England, which produces almost no copper, is one of the largest refiners because of its cheap coal, favorable conditions for cheap importation, and the large local market. For the same reasons, Belgium and Germany are also important in copper refining.

Copper Scrap. This metal is almost indestructible and scrap supplies are becoming increasingly important competitors for newly mined copper. As with iron and steel scrap, this situation is most significant in the older industrial nations, such as the United States, Germany, the United Kingdom, and France. In the United States, for instance, in 1934, during the depths of the depression, many mines and smelters were closed because the market was so small it did not justify operations. In that year 60 per cent of the copper consumed by American industry was scrap. By 1938 recovery had proceeded to the point where scrap furnished but 40 per cent. In addition to the large smelters and refineries for newly mined copper mentioned above, there are in railroad and industrial centers throughout the United States and other industrial nations a number of smaller ones which operate on the local supply of copper scrap.

The Geography of Copper

United States. The United States is by far the largest producer of copper and has immense reserves

for the future. In addition, American interests have financed and developed some of the most important foreign deposits.

The principal producing districts are in the West, except for one important mining area in Michigan and a smaller one at Ducktown, Tennessee. Arizona is the leading state in production, almost all of the mining occurring in the southeastern part of the state, in the Globe, Bisbee, and Jerome districts. Most of the ore worked comes from low-grade deposits of tremendous size, although some relatively high-grade deposits are also utilized. Utah is usually second in production, also from low-grade ores. The Butte district in Montana is usually third. Here, most of the ore comes from deep veins. The Michigan deposits are in the Upper Peninsula, in the vicinity of Houghton. The ores occur usually as veins or narrow zones deeply buried, and the cost of production is relatively high. Some of the metal occurs as *native* copper, that is, in blocks of considerable size that are almost pure copper Other deposits of importance occur in Nevada, New Mexico, and Alaska.

Of the eleven electrolytic refineries in the United States, five are in the New York district and at Baltimore. They operate with coal from the Appalachian field and use both domestic and imported blister copper. Two other refineries are at ports on the Great Lakes where lake transport makes cheap coal available, and one is at Hubbell, Michigan, in the heart of that state's copper district. Others are at Great Falls, Montana; Tacoma, Washington; and El Paso, Texas.

The high conductivity of copper accounts for its principal uses. Electrical manufactures annually consume four or five times as much copper as the building trades, which are the second users in rank. Most electrical goods are manufactured in New England and the Middle Atlantic states and this is the principal market for copper. Brass (a copper and zinc alloy) and bronze are also largely manufactured in the East.

Canada. Canada has just recently risen to an important position as a copper producer. About half the present production comes from the Sudbury nickel district just north of Lake Huron in Ontario where mines were opened because the ore is mixed with nickel and the recovery of both metals makes mining relatively profitable, even though the operations are of the vein type and the better deposits lie far beneath the surface. The Rouyn gold district in northwestern Quebec is the second most important producer; here, again, another metal was the original reason for starting operations—indeed, recent high prices for gold have made production almost independent of the price of copper. Zinc and copper are mined together at Flin Flon in northwestern Manitoba. In British Columbia, just north of the United States boundary, there are immense reserves of low-grade copper ore widely dispersed throughout limestone rock. There is some mining here, but extensive development must await higher copper prices. Canada exports most of its copper as blister and the United Kingdom and the United States receive the bulk of it.

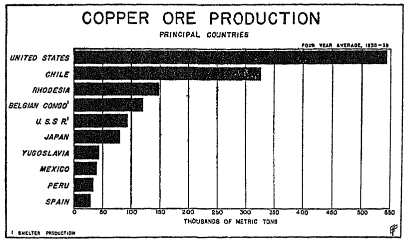


Figure 184. Many of the industrialized nations lack adequate supplies of this basic raw material

Mexico. In this country, most of the copper production comes from the states of Sonora and Chihuahua, not far from the American boundary. These deposits seem to be a continuation of the Arizona districts already mentioned. The development has been at the hands of American companies, and much of the ore has been shipped to smelters in Arizona.

Chile. Chile has usually been second in copper production, but this position is now being threatened by both Canada and Africa. There are three principal deposits. One is at Chuquicamata in the desert of northern Chile. Tremendous quantities of low-grade ore are available and American interests have developed them by large-scale methods. The other large mines in Chile—those of the Braden Copper Company near Santiago, and the Potrerillos Mine in the southern part of the Atacama Desert—are also products of American development. Relative nearness to water transport and low costs of production are important considerations in accounting for the rank of the Chilean deposits in world production.

African Producers. The principal African deposits are in the far interior, in Rhodesia and the Belgian Congo. Until recently, lack of transport hindered their development, but the construction of railroads to the coast has now made these deposits available.

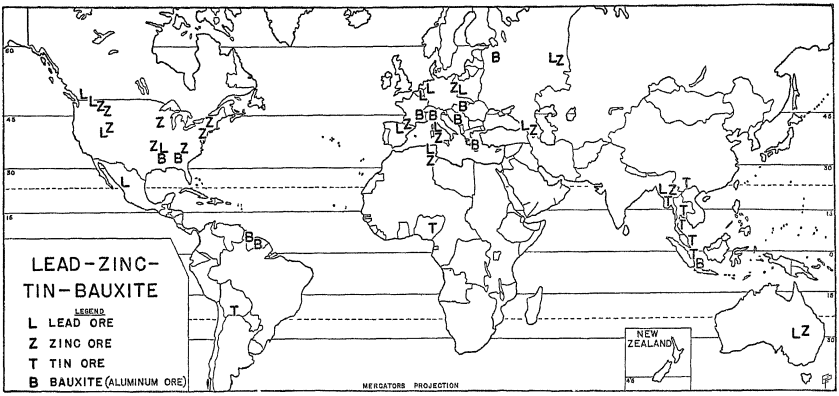


Figure 185.

In general, there are large quantities of very rich ore and costs of mining are low. These factors help to overcome the handicap of an expensive rail haul to the coast. Most of the developments are in the hands of British and Belgian companies and most of the copper goes ultimately to Europe.

U.S.S.R. Russia has been and still is to some degree an importer of copper, but promises to achieve self-sufficiency in this as in other industries. In 1938 this country was sixth in the smelter production of copper. The largest deposits are in Kazakstan (southwestern Asiatic Russia) near Lake Balkhash, and the mineral district in the Ural Mountains also contains important quantities of copper ore. Other deposits which are now worked are in the Middle Volga region and on the Kola Peninsula in the extreme northwest of European Russia. There are new refineries at Kasakpai in Kazakstan, Sreduralmedstroi in the mid-Ural district, Bliava on the Middle Volga, and a nickel and coppery refinery at Monchegorsk on the Kola Peninsula.

Other Producers. Copper is the only important industrial metal of which Japan has an adequate supply. Ore is widely distributed over the country. Other copper deposits of importance are thought to exist in Asia, but lack of market, isolation, and lack of transportation have prevented their exploitation.

Cerro de Pasco, in the high Andean Plateau, is an important producer in Peru. High-grade ores are mined in the Rio Tinto district in Spain, and Portugal and Germany also produce small quantities. The island of Tasmania and the state of Queensland in Australia are the only important producers in Oceania

QUESTIONS FOR DISCUSSION

1. Are coal, ore deposits, and market of the same relative importance in locating the copper industry as in locating the iron and steel industry? Explain.
2. Is it probable that the copper industry may eventually be able to use scrap as its sole source of raw material?
3. Do you expect the use of copper to increase or decrease in the future? What substitutes may be used for it?

Aluminum

Although its development started but fifty years ago, this metal has already grown to be of tremendous significance and may further revolutionize the whole field of mineral use. It is light in weight, tough, and its alloys possess great strength. In addition, it is almost as efficient a conductor of electricity as copper. While it has been used as a raw material for the manufacture of cooking utensils for some time, its greatest use has come about through the development of aluminum alloys, largely since 1910 In all forms of transportation, strength combined with lightness brings about marked savings in power; consequently aluminum alloys have gone into the construction of automobiles, boats, railroad rolling stock, and aircraft in increasing quantities. Although copper, manganese, and steel are the commonest metals combined with aluminum in making alloys, research is constantly going forward and new combinations of value may be expected to be discovered.

Although steel for structural purposes and copper for the transmission of electricity are now dominant, they hold this position only because they are cheaper than aluminum and aluminum alloys at present. If new techniques of refining aluminum ore were discovered which would make aluminum as cheap as steel, there might well occur a revolution in industry which would almost compare with the Industrial Revolution in significance.

Aluminum Ore. The compound from which aluminum is made is *alumina,* a substance which makes up a very large proportion of the total material of the earth's crust, but which is difficult to extract. As a consequence, rock to be classed as ore must contain at least 50 per cent alumina. The commonest ore is bauxite, named from the town of Baux, in southern France, where it occurs in large quantities. Bauxite usually occurs in thin, interrupted seams at or near the surface and is generally considered to be the product of the weathering of older rocks.

All of the exploited bauxite deposits in the United States are in the South. By far the most important is that in central Arkansas, and this state has supplied more than three-quarters of the ore mined in the United States to date. Other producing deposits are in northwestern Georgia and northeastern Alabama, and near Chattanooga, Tennessee. The location of the American deposits is not ideal and labor costs are relatively high, so American ores have suffered keen competition from those produced from deposits near the seaboard in foreign countries.

About half the American ore is used in making abrasives and chemicals; the rest goes to the aluminum industry. Two-thirds of the latter industry's demands must be met with imported ore. Dutch Guiana supplies about three-quarters of this import, and British Guiana and Greece most of the remainder.

France was for a long time the only important producer of bauxite. Now she is followed rather closely by Hungary and the United States. At present Dutch Guiana, Italy, Yugoslavia, British Guiana, and U.S.S.R. are also important producers.

Most of the refineries in Europe are in France, Germany, Switzerland, Norway, and Italy. All have considerable water power, but all except France depend on imported ore. In 1938 Germany was the world's leading producer of refined aluminum. She produced practically no bauxite, but had cheap coal, thus demonstrating the tremendous importance of power resources in this industry. England is a relatively small producer because of the lack of cheap hydroelectric power.

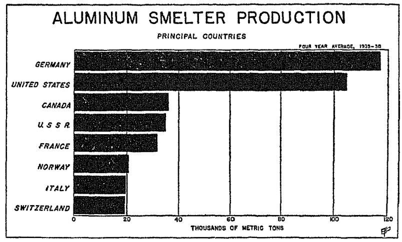


Figure 186 Much of this production is based on imported bauxite.

The Location of Refineries. Aluminum ore is valuable and is, therefore, profitably shipped great distances. It is consumed only in the great manufacturing countries and requires large quantities of cheap electricity for refining. These factors have resulted in the concentration of aluminum refining in eastern North America and northwestern Europe. There are two steps to the process. The ore must first be "calcined" to free it of impurities which would interfere with electrolytic refining. Ores produced in the United States and large quantities of imported ore are calcined in East St. Louis, which is a railroad center and has access to cheap coal, and at Mobile, Alabama, where a new plant refines domestic and imported ores with coal from the Birmingham fields. When this has been done, the ore is then shipped to large hydroelectric plants at Alcoa, in eastern Tennessee; Badin, North Carolina, or to Niagara Falls or Massena, New York. Here, the electrolytic refining is done, and the pure aluminum is ready to serve as a raw material for manufacture. The recent construction of a calcining plant at Arvida, Quebec, and two mammoth electrolytic refineries on the Saguenay River in that same province are events of outstanding importance. Ore may be cheaply imported by water transport, cheap electricity is available in large quantities, and labor is inexpensive. This development is in the hands of American interests and promises to depend almost wholly on bauxite from deposits in the Guianas. The Canadian product is largely exported to the United Kingdom and Japan.

Tin

Although tin was known to the ancient world as an important element with copper in the alloy bronze, and in recent centuries as a roofing material, its real

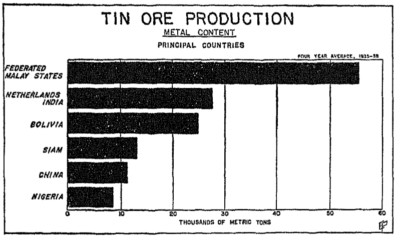


Figure 187.

importance began with the invention of the lowly tin can and with the demand for it as a part of solder and Babbitt metal. Its value is due to several qualities. It is unaffected by air and is practically unaffected by many acids, such as those in fruits and vegetables. This latter quality has made it ideal for use in containers for the preservation of food and its consumption has increased with the increase in canning. The "tin can" is actually a thin sheet of iron or steel coated with tin. It is ductile and fuses at low temperatures, thus making it, with lead, an important ingredient of solder. Babbitt metal for bearings is usually made of tin, antimony, and copper.

One of the interesting things about tin is that, although its present uses are very important, there are already visible substitutes which may conceivably take its place in the future. Aluminum is as good a preservative of food, but tin plate is still somewhat cheaper. In addition, a thin coating of lacquer on steel or iron is also being used in increasing quantities. Roller and ball bearings are being substituted for Babbitt metal to a considerable degree and there are many substitutes for tin as a roofing material.

No other major metal is so universally absent in the principal areas of consumption. Tin plate is manufactured only in the great industrial nations of Europe and North America and most of the ore comes from southeastern Asia, Africa, and South America. This combination of factors has made tin bulk large in the minds of those concerned with the international strategy of minerals.

Tin Ore. Although tin occurs in thin veins in the rock, most of the commercial production comes from the placer deposits in the valleys of rivers which have been eroding tin-bearing rocks for countless ages and have concentrated the tin by depositing it in the gravels of their bars.

Production. The greatest tin-producing district lies in southeastern Asia and extends from the islands of Billiton and Banka in the Dutch East Indies through the Malay States and Siam into Burma. Here all of the tin is produced from stream gravels, as is the case in Nigeria, the other important tin-producing district in the Eastern Hemisphere. Bolivia is the only country producing large amounts of tin from vein deposits. The ores are located in the high Andean Plateau and suffer from high cost of transport, and high costs of extraction, although, for vein deposits, the ore is relatively rich. The tin deposits of Cornwall, in England, which have been known and worked for centuries, are also vein deposits, but the present production is very small.

Smelting. The location of smelters is affected by both physical and political factors. Large quantities of coal are used, and Singapore, which is a shipping center and has relatively cheap fuel, is an important smelting center for Eastern ores. Recently, the Dutch have erected a large smelter at Batavia, Java. Most Bolivian tin is smelted in Germany or England. The Bristol Channel ports in Great Britain smelt the largest part of the world supply. This concentration of smelting in the hands of the British is due in part to their traditional significance in the industry because of the former importance of the Cornwall deposits, to their position in the center of the world market, to the abundance of cheap coal in Wales, and to high tariffs on the export of ore and concentrates from British colonies to be smelted outside of the Empire. Most American tin imports come from English smelters.

Tin Consumption. All the greatest steel-producing nations are important manufacturers of tin plate. However, since canned food is relatively expensive, the high-income market makes the United States the largest consumer of canned goods and therefore of tin plate and tin. The American consumption of tin averages three to four times that of the United Kingdom, which ranks second. An interesting note in tin consumption is the rapid rise of Russia and Japan. Growing standards of living and the existence of large areas with long winters have turned the U.S.S.R. into a tremendous canner of foods that are produced in her more temperate lands The U.S.S.R. took three times as much tin from the world market in 1938 as in the previous year. Japan has embarked upon the canning of fish, especially, and its export to foreign markets helps to pay for raw materials in which she is deficient.

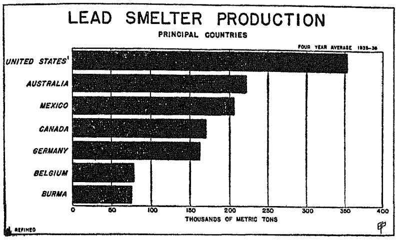


Figure 188

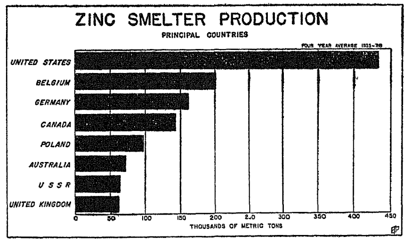


Figure 189.

QUESTIONS FOR DISCUSSION

1. For what uses would you prefer aluminum and for what uses would you prefer stainless steel?
2. How is the price of a metal usually determined? Does the increased production of a metal usually increase its price, decrease it, or may it cause either kind of price change, depending on other conditions? Explain.
3. Is the price of tin likely to rise to great heights because a very few producers control the tin ore of the world? Explain.

Lead

The uses of lead in manufacturing, construction, and the electrical industry are almost too numerous to mention. Only iron exceeds it in the variety of its uses. The ease with which it is shaped, its resistance to acids, and its low melting point are the properties which account for most of its uses. Storage batteries, paint, and cable-coverings are the principal uses for lead in the United States.

Like tin, lead is consumed most largely in the highly developed manufacturing countries, but, unlike tin, it is produced most largely in and near those countries.

The Occurrence of Lead. Although lead occurs as a simple ore in the mineral *galena,* most of the world's production comes from ores containing lead and a variety of other metals. It occurs very frequently with zinc and silver and often with copper and gold. The result is a production which varies not only with the price of lead, but also with the prices of the other metals in the ore. Thus, many of the problems of joint cost affect the lead industry.

Principal Lead Districts. Although lead is produced in a score of countries, eight of them produce more than 90 per cent of the world total. North America produces about 45 per cent, and the United States, alone, about 20 per cent. Southeastern Missouri contains the world's most important lead district and the only large deposit where lead does not occur in association with other minerals. In the Tri-state District—where Missouri, Kansas, and Oklahoma meet—there is an important production of ore containing both lead and zinc. The mineral districts of the Western states, already mentioned in the discussion of copper, also produce lead in a complex association with other ores. The smelting of lead from an ore in which lead occurs alone is relatively easy because of the low melting point of lead, but the adaptation of a selective flotation process to the treatment of the most complex ores has tremendously increased the recovery of all the metals contained in them. Thus, most of the large smelters are engaged in recovering everything possible from ore, rather than any single metal.

Both Canada and Mexico are becoming of increasing importance in lead production. The complex ores of the mineralized district of northwestern Mexico contain lead in association with other minerals and, with the introduction of modern smelting methods, the recovery is large. The greatest production in Canada comes from the Sullivan Mine in southern British Columbia where it is found in association with zinc. Other producing districts occur in Ontario and Quebec.

In Europe, the principal production comes from deposits in Silesia, all of which is now under German control. The Spanish mines in the Sierra Morena have been worked for centuries, and the cost of production is now high. Broken Hill District in New South Wales is the principal Australian producer and puts that country in second place among the world's lead producers. Burma accounts for most of the output from Asia.

Zinc

This metal, like tin, finds its main use as a coating to prevent the rusting of steel and as an alloy with copper to make brass. Most of the zinc is produced in

or near the industrial countries, and Europe now produces about one-half of the supply. Zinc usually occurs in association with lead and often with many other metals The Tristate Lead and Zinc District—Oklahoma, Kansas, and Missouri—is the world's largest single producer. Near Franklin, New Jersey, is a deposit which produces zinc alone and which has been so intensively developed in recent years that it is now the second most important district in the United States. Most of the Western mineral districts of the United States also produce considerable zinc.

Canada and Mexico produce zinc from the same districts mentioned in the discussion of lead. Silesian lead and zinc deposits account for the importance of Germany in the production figures. Italy has zinc deposits both in the northeast and in Sardinia. The principal production of zinc in Spain comes from deposits along the north coast. Burma and Australia produce important amounts of zinc in their lead-zinc districts. The U.S.S.R. gets its home production largely from mines in the Kola Peninsula in the extreme northwest.

The Future of the Metals

Considering the world as a whole, there is no important metal for which there appears to be any immediate danger of a shortage. Perhaps tin is least plentiful in terms of present use, but substitutes are already appearing. Predictions as to the life of the world reserves of any metal are largely useless because they involve no knowledge of price or techniques of recovery in the future. If improvements in methods of mining and refining such as have been made in copper were to be developed for other metals, they would upset any predictions that might be made. The present condition in most of the mineral industries is one of overproduction, and this promises to prevail for some time in the future.

Secondary Supplies of Metals. One of the really promising aspects of the problem of future supplies of the metals is the large past and present consumption, strange as that may seem. Most of the uses of metals are not destructive and when a metal object has outrun its usefulness, the metal of which it is made goes to the scrap heap and back into the furnace. Any industrial nation has on hand, in the annual supply of scrap, a potential supply of metal for emergencies. It is estimated, for instance, that 80 per cent of the copper used is recoverable and that most of the recoverable proportion does find its way back into industry, eventually. Germany, which produces very little new copper from mines, kept going for four years during the World War on a carefully hoarded supply of scrap. At the present rate of consumption, the United States could probably live on her potential supplies of scrap for twenty-five years.

Tariffs and Conservation. Governments are continually being urged to impose tariffs on imports of minerals to encourage home production from deposits which suffer some handicap of cost or quality as compared with foreign deposits. Most authorities on mineral conservation frown on this as a general policy, since it speeds up the exhaustion of home supplies and increases the price to home consumers. In some cases it has been justified on the grounds that it encouraged sufficient home production to assure the large production necessary to make refining or manufacturing cheap.

The military argument is sometimes used to support a tariff on mineral imports. A going home industry is a valuable asset in time of war when imports might be interrupted. Other military experts have proposed a careful canvass of resources within the country, to serve as a basis for production when needed, and the keeping on hand of supplies of imported materials sufficient to last through any probable period of emergency or until domestic production could be assured. In addition, any nation which has long consumed a metal has a large potential supply of scrap on hand, and high war prices will bring it into the market. The lack of domestic mine production of basic metals is no longer the military nightmare that it once appeared.

QUESTIONS FOR DISCUSSION

1. To what extent are minerals dissipated by oxidation? by use in chemicals? by electrical use? by use in plating?
2. Do you favor a protective tariff on minerals? Do you think an export duty on minerals (if constitutional) would be a good conservation measure? How would each affect prices within the country and abroad?
3. What would be the "revolutionary" consequences of cheap aluminum? Look up the present market price of aluminum, iron, copper, and tin.

CHAPTER 31

NONMETALLIC MINERALS

THE PRESENT era has sometimes been called "the iron and steel age" because of the many ways in which iron contributes to modern life. Modern civilization has also been described as a "power economy" because of the tremendous amounts of coal, petroleum, and water power used in production. Rarely has much emphasis been placed on many nonmetallic [1] minerals which are almost equally important. Many of these—such as sand, clay, and salt—have been so commonplace that they are often overlooked in discussions of minerals. Others—such as phosphorus, fluor spar, and bromine—are used in rather small quantities, but without their assistance many larger industries could not exist. Certainly modern civilization would be radically altered if bricks, cement, building stone, sand, clay, and other nonmetallic minerals to be discussed in this chapter were eliminated.

The importance of these nonmetallic minerals in annual production is suggested by Fig. 190. Comparable figures for iron ore are included for comparison A few of the important minerals, such as asbestos and the nitrates, are omitted since they are not mined in large quantities in the United States.

The Conservation Problem. With a few exceptions, the reserves of the nonmetallic minerals are so great that there is little need for conservation. Local shortages, of course, exist, but except for petroleum, coal, and possibly sulphur, the world is not likely to be seriously inconvenienced by any probable shortage. Even if a shortage should develop, there are many satisfactory substitutes. Finally, with the exceptions mentioned above and a few minerals in the chemical industries, the nonmetallic minerals are not totally destroyed in use. For example, in the building industries, the wreckers recover many bricks, stones, and other materials Even more could be recovered if prices justified it.

[1] A metal is defined as an element that forms a base when combined with hydrogen and oxygen Usually metals are hard, heavy, lustrous, malleable, ductile, and fairly good conductors of heat and electricity Certain salts of metals (as sodium chloride or common salt) are commonly considered as nonmetallic minerals although they have a metallic content.

Figure 190 [2]

VALUE OF UNITED STATES PRODUCTION OF IRON ORE AND IMPORTANT NONMETALLIC MINERALS, 1937

(thousands of dollars)

Iron ore	207,828
Building materials	
Clay and clay products	214,045
Cement	171,414
Stone	146,213
Sand and gravel	92,726
Lime	30,091
Slate	5,605
Gypsum	4,783
Fertilizers and other chemicals	
Sulphur	44,300
Salt	24,132
Phosphates	12,975
Potassium salts	9,020
Borates (borax, etc)	7,233
Bromine	5,180

The Nonmetallic Minerals as Industrial Raw Materials

After wood, leaves, straw, skins, and bones, certain of the nonmetals were the next raw materials to be adopted by man. Boulders, roughly chipped stones, and a few earthy pigments were probably used by man in his earliest development. As man left the Paleolithic (Old Stone Age) and attained the Neolithic (New Stone Age) culture, among the most significant signs of his progress was his further control over the nonmetals by polishing his stone tools and learning to make pottery. Somewhat later, probably about the beginning of written history, bricks and glass were added to the industrial raw materials. About the same time, masonry was developed and, later, the use of mortar and cement. From antiquity until the Industrial Revolution, the nonmetallic minerals together with plant and animal materials, formed the major raw materials for the artisans; the metals were relatively expensive and were thus used mainly for luxury goods and for sharp tools, weapons, armor,

[2] *Statistical Abstract of the United States*, 1938.

and a few other uses for which they were especially suited. The Mechanical and Industrial revolutions with their emphasis on the machine focused attention on the metals and on those nonmetals which supplied fuel and power. The great amount of engineering genius concentrated on the development of materials for the machine resulted in rapid progress in the metals industries. Recently, increased attention has been paid to the nonmetals, and it is possible that as many new and greater uses will be found for them in the present century as were found for metals and fuels in the last century.

Clay and Ceramics. Common clay is found in almost every part of the world; in fact, it is an important ingredient of all fertile soils. Its widespread distribution and ease of working account for its great use by all peoples, be they primitive or highly civilized. Technically, clay is defined as fine earthy particles which are largely hydrous aluminum silicates. Its deposits are formed in place by the decomposition of bedrocks (especially those containing feldspar); or the clay may be washed from the soil and concentrated in deposits in the beds of rivers, lakes, and oceans. Common clays contain many impurities and vary accordingly in color and properties.

Common clays will often make satisfactory pottery and were used for this purpose by primitive man. Fine ceramic wares, however, are generally made from unusually pure deposits of clay to which other substances such as quartz and feldspar have been added to increase the strength. The cheaper wares are made from the mediocre qualities of clay, but the best white china must be made from *kaolin* (china clay). Large deposits of this clay have often located important pottery industries, as, for example, at "The Potteries" in central England, at Limoges, France, and at Trenton, New Jersey In the last center, the best local clays have become exhausted and kaolin is now imported from England. So important is skilled labor in the better grade pottery industries that kaolin is exported from Czechoslovakia and England to pottery centers in many nations. The United States imports from England several hundred thousand tons of kaolin each year for its china manufactures, although there are large deposits of mediocre clays throughout the country.

As in many other industries, cheap and bulky products cannot stand the high costs of transportation. Thus the American ceramic industry has little competition in its home market for porcelain washstands and bathtubs. In the production of high-grade dishes, international competition is more strenuous, and American manufacturers who pay high wages find it almost impossible to compete with the products of Limoges, Dresden, Delft, "The Potteries," and Japanese centers. Even when tariffs make competition possible on a price basis, foreign china is preferred by many American consumers to American china of equal quality, because of the long-established reputation of the foreign wares.

Sand and the Glass Industry. Glass is fused sand just as pottery is essentially fused clay. The term *sand*, as used in the chapter on soils, referred especially to the size of the soil particle. Although sand sometimes consists of limestone or other rock, the major element in most sand is silica (silicon dioxide), which is the principal ingredient in glass. Since the most valuable property of most glass is its transparency, only the purest silica sand can be used for glass making. Even the slightest impurity will color the glass—in fact, colored glass is obtained by adding minute amounts of other minerals to the molten glass[1]

The manufacture of glass requires much more skill than the manufacture of pottery. The industry is consequently not found among the most primitive peoples or in nonindustrialized regions. Within industrial regions, deposits of pure sand were often important as a locating factor. For example, the glass industry of southern New Jersey used the pure sands of the coastal plain on which it was located. The pine woods in the vicinity provided sufficient fuel in the form of charcoal for the early industry; when this fuel supply became exhausted, oil was substituted.

The early glass industry manufactured mostly small pieces of glassware, bottles, and small panes of window glass. Mechanization has not only greatly reduced the price of these articles and thus extended their use but has also made possible the cheap manufacture of large pieces of window and plate glass. In this mechanized, large-scale industry, cheap fuel is a more important locating factor than near-by glass sand Hence, modern glass factories are near natural gas fields or near supplies of coal from which gas can be manufactured. In the United States such an area is found near the coal and natural gas fields around the Ohio Valley. Fortunately, sandstone formations (Oriskany and St. Peter sandstones) from which glass sand can be derived are common from Missouri to Pennsylvania. In Europe, the glass industries are especially

[1] The minimum precentages of silica in sands to be used for glasses of various qualities are as follows

For optical glass	99 8 per cent
For best table and plate glass	98 5 per cent
For window glass	98.0 per cent
For colored bottles, etc.	95 0 per cent

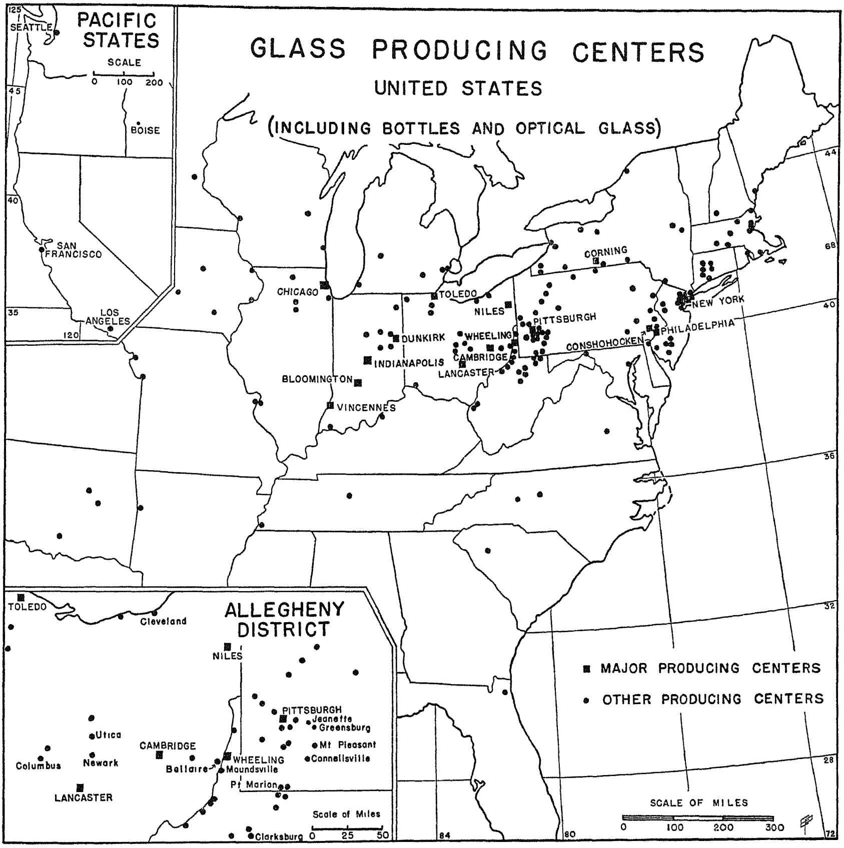


Figure 191. Except in the production of fine glass, cheap fuel is a necessary locating factor.

important near the coal fields of Germany, Belgium, Czechoslovakia, and France.

Glass is rarely made only from sand, for the addition of fluxes (soda ash, lime, etc.) and other substances will alter its color, hardness, and other qualities. Within the present century many new types of glass have been developed which utilize many more properties than its transparency. Glass is resistant to moisture, gases, and most chemicals, and is not subject to warping. These qualities have made it an attractive new material used for a variety of things from cooking dishes to glass bricks and fireproof textiles. New methods may even overcome the great handicap of glass, its fragility. Safety glass is a partial solution of this problem, a newer European process is said to toughen glass until its strength is comparable to that of wrought iron. If glass can, to some extent, replace metal, it may solve many conservation problems since large reserves of glass sand are widespread and will outlast most ore deposits.

Abrasives. Many of the materials used for abrasives are common—for example, sand and sandstone; others are limited in distribution—for example, diamonds. To these natural abrasives must be added such artificial abrasives as carborundum (made by fusing sawdust and quartz in an electric furnace) Altogether, about 200,000 tons of abrasives are used annually in the United States. Their uses are often overlooked, yet they sharpen every tool, grind up many raw materials, and smooth the surfaces of numerous manufactured articles. Fortunately they are not scarce, except for diamonds (obtained mostly from South Africa and Brazil), adequate supplies of abrasives are found in almost every industrial country, and their bulk is so small that they may be shipped, cheaply, to deficit areas

Decorative Materials. Earthy materials, such as clay and ochre, have always been used for decorating the human body; in some tropical regions paint even precedes clothing as a means of adornment. Today, these materials enter into a wide variety of decorative articles such as cosmetics, paints, clay for sculptors, and plaster casts The materials used are common, but often they are imported from other lands to obtain some delicate tint or other fine quality.

QUESTIONS FOR DISCUSSION

1. Glazes and enamels are used in the manufacture of most ceramics. Are the raw materials used in these glazes an important locating factor in the industry?
2. Does style play an important part in the pottery and glass industries? How?
3. Disregarding the tariff, glass can be manufactured and shipped to New York City more cheaply from Charleroi, Belgium, than from Pittsburgh, Pennsylvania In what ways might this fact be explained?

The Construction Industries

The environment influences the constructional works of man in two important ways: it suggests the need, whether it be for shelter, a dam, or a bridge, and it contributes to the raw materials from which the structure is erected. Examples of the first influence are: slanted roofs in rainy areas, thick walls in cold areas, dams for irrigation or flood control, and bridges over streams and canyons. The control of local raw materials is especially evident in primitive societies and in the less ornate buildings Brunhes[1] points out how, on plains of European Russia, the peasant huts reflect the available raw materials. Thus, on the tundra, crude huts of stone and driftwood or tents of reindeer hide make up the few human dwellings. In the northern forest, the log cabin is the common form. As the forest disappears on the steppes, the mud or sod house becomes predominant. To the south, in the Crimea and on the edge of the Caucasus Mountains, the steppes become less grassy and more stony, hence the stone house predominates.

Good transportation, of course, permits the use of building materials from distant lands, but usually these materials are so heavy and so bulky that the high cost of shipment discourages their use if satisfactory materials can be obtained near by. Perhaps the most striking example of this is the contrast between houses in the northeastern United States and northwestern Europe. For centuries, the stone house has predominated in the European region except in a few countries (Norway, Sweden, and Switzerland especially) where large forests still existed. Equally universal was the wooden house in the United States Recently, the number of wooden houses has declined because of higher lumber prices, the desire for larger and stronger buildings, and because of the fire danger in congested areas

For more monumental buildings, materials—especially those used for surface decoration—are shipped all over the world. The fine white marble of Carrara, Italy, and the marbles of Vermont, Tennessee, and Georgia are shipped great distances. With the decreased cost of long-distance transportation, shipments of fine building stones have increased. As a result, many local quarries producing mediocre stones have been closed because of the competitive price of better stones from distant states.

Even though it may be possible to purchase distant supplies, the architect finds he can do the most for the money, except on de luxe projects, by using near-by materials where possible. As a result buildings constructed during a certain period frequently have a sameness of appearance. The brownstone houses of New York City and the red brick (with marble or limestone trim) houses of Philadelphia and Baltimore reflect locally available raw materials. The environment did not force these materials on the builder, but it was to his best advantage to use them.

Another type of building material that is shipped long distances—even across the ocean—includes goods used for ballast in ships or as return loads for freight cars. For example, ships sailing from America to Europe carry heavy loads of raw materials—grain, minerals, lumber, and the like; the return cargo consists of manufactures which are relatively light. Thus, to balance his traffic the ship operator is willing to carry

[1] J Brunhes, *Human Geography*, p. 79 (trans. from the French) Rand McNally & Co., New York, 1920.

such articles as coal, sand, bricks, cement, and china clay for a nominal charge.

The Trend toward Nonmetallic Minerals. Wood, hides, felt, straw, and sod are easy materials with which to work and, wherever available, were the building materials during the early development of civilization. The nonmetallic minerals were first developed as building materials where other materials were scarce. Thus, in ancient Egypt, mud was used (as it is today) for the peasants' huts, brick for the better buildings, and stone of the Nile Valley for temples, tombs, and parts of the palaces. In the Tigris-Euphrates Valley, good building stone was rare and only mud and bricks were used The brickwork was often more ornate than in Egypt, where stone was used for ornament.

Increasing urbanization and the development of engineering have been accompanied by the increasing use of nonmetals in the construction industries. In part, this trend reflects the increasing price of lumber and other materials. In large cities the greater need for fireproofing (and more recently the development of soundproofing) is best met by the use of nonmetals. Likewise, buildings are more easily insulated against weather changes when stone, brick, or concrete are used. Finally, and probably most important, is the need for greater strength than wood can supply. The huge dams, tall skyscrapers, and smooth motor roads of the present century are almost inconceivable without nonmetallic-mineral building materials.

The quantity of raw materials used in modern skyscrapers is astounding. For example, the Empire State Building in New York City weighs about 303,000 tons. Of this about one-fifth is in the steel framework and most of the remainder in concrete, brick, stone, and other nonmetallic minerals If these materials were brought to the site by a single freight train, it would have to be fifty-seven miles long. The assembly of such an architectural mass needs both the strength of structural steel and the nonmetals, as well as an efficient transportation system.

The Geography of the Nonmetallic Building Materials. Since, as has already been stressed, these materials are of local origin when possible, their geography cannot be thoroughly treated without a consideration of innumerable localities. The following discussion outlines only the most universally applicable points. For details of any locality, the reports of the United States and state geological surveys should be consulted. Local architects and builders can provide more up-to-date information.

Bedrock. Except where caves are used, the bedrock is not usually considered a part of a structure. Nevertheless the nature of this rock greatly influences the possible form of the project. If a valley is to be dammed up, it is advantageous if the rock on the sides and bottom of the valley is nonporous. If a skyscraper is erected, it is advantageous to be able to anchor it in solid rock. Even in the erection of small residences, the nature of the soil and the rock beneath it influences the cost of excavation, the solidity of the structure, and the freedom of the cellar from moisture.

Clay as a Structural Material. Clay is an easy material to work; it can be converted into brick with the simplest and crudest of tools. Its simplest use is in the mud hut, which is common in arid lands, and usable even in rainy lands if the mud wall is protected by an overhanging roof. Sun-baked clay or adobe is more permanent. Fire-baked brick is resistant to even the heaviest rains.

The clays and shales used for common red bricks are so universal that each brickyard usually supplies a near-by market. Where clays of special composition are found, bricks of other colors may be produced. For example, calcareous clays produce cream-colored bricks Bricks of unusual color are often shipped long distances to serve as fancy facing for buildings. Likewise, bricks made of fire clay and used in furnace linings are also shipped to distant markets.

Slate. When clay is compressed into rock it is called shale, and when this shale is subjected to great pressure due to earth movements it is converted into slate. Hence, slate is usually found in mountainous regions. Most of the United States production is from the edge of the folded Appalachians, especially in Pennsylvania and Vermont. Slate is used widely as roofing, insulating material, and for blackboards.

Building Stone. The common building stones are (in order of their importance) limestone, granite, sandstone, basalt, and marble. Of these limestone and sandstone are widely distributed in plains and mountains, while the others (which are generally harder) are associated with rugged regions. The hardness of marble, for example, is due to the tremendous pressure to which it has been subjected during the process of mountain making.

The cheaper building stones are ordinarily used as the principal material in many buildings. On the other hand, more valuable stones are often sliced thin and used as facing over an underlying wall of brick or concrete. Many of these facing stones are shipped long distances, especially if the architect wishes some special color combination. The many

colors of marble found in the Library of Congress at Washington were obtained by importing stones from Algeria, Greece, Italy, Belgium, Alaska, Georgia, New York, Tennessee, and Vermont.

The bulk of the limestone used as trim and facing for buildings in the United States is obtained from Indiana. It is a white oolitic stone which has the advantage of being fairly easy to work when it is first quarried, although it hardens into a very durable rock after exposure to the air. The carved white stone facings found on so many office buildings throughout the United States are usually of this Indiana (or *Bedford,* named from Bedford, Indiana) limestone.

The other major American building-stone area is Vermont. Here the folding of the Green Mountains has produced an unusually hard and white marble (near Rutland). A hard granite which takes a fine polish occurs near Barre.

Cement. Building stone must be quarried and cut into shape by blasting, drilling, and polishing. For large buildings, dams, and other masonry structures, it is much easier to make artificial stone which is poured or molded into the proper shape. The common material used is cement.

Cement was known to the Romans, but the secret of making it was lost during the Middle Ages. It was rediscovered in England in 1756, and several varieties have since been produced. Cement may be defined as a prepared material that sets and forms a stonelike substance after it has been mixed with water. At present Portland cement (so called because when set it resembled the Portland stone used for building in England) is the most common kind produced. It is a finely ground mixture of limestone and clay (about 61 per cent); marl and clay (2 per cent); blast-furnace slag and limestone (10 per cent); and cement rock [1] and limestone (27 per cent).

Northeastern Pennsylvania leads in the production of cement. In the Lehigh Valley there are extensive deposits of rock which contain nearly the right elements to make a perfect cement. At some plants more limestone must be added, elsewhere, more clay is added to make the proper mixture. The minerals are ground into a fine powder, mixed thoroughly and then burned at 3000° F. and reground. The resulting powder can be used to make artificial rock and will set even under water.

Cement is frequently mixed with crushed stone and sand (which are cheaper than cement); this mixture, when set, is known as *concrete.* Concrete and cement both expand at the same rate as iron and steel; hence they may be used around steel frameworks without danger of cracking. When combined with steel in this way, the product is called *reinforced concrete.*

The materials for making cement are widespread and it is not difficult to manufacture a fair grade of product. England, Germany, Belgium, and eastern United States export some cement to nonindustrialized parts of the world, but cement plants are found in nonindustrialized countries where there is a steady demand for their product. There are plants in Bulgaria, Peru, Sumatra, China, and Australia. They are, of course, even more common in the industrialized countries; thus cement plants are found in twenty-nine of the forty-eight states of the United States.

Sand and Gravel. A large part of the production of sand and gravel is used with cement in making concrete. The business is made up of a large number of small units, each supplying a very limited market. Production is extremely unstable and varies with the season of the year and with the ups and downs of the business cycle. This fluctuation is characteristic of all construction industries. When business is booming, the demand for building materials is high; during depressions, only necessary replacements are made unless public works are used by the government as a recovery and relief measure. Figure 192 shows the effect of the recent depression on the sand and gravel industry.

Figure 192

PRODUCTION OF SAND AND GRAVEL, UNITED STATES, 1929-1937

Year	*Millions of tons*	*Millions of dollars*
1929	222	132
1930	197	115
1931	153	86
1932	120	57
1933	107	53
1934	116	61
1935	125	66
1936	175	86
1937	186	92

Plaster Materials. The two principal plaster materials are *lime* (calcium oxide) and *gypsum* (calcium sulphate). These are used (in various combinations with sand, cement, and other substances) as mortar and wall plaster. Lime is obtained from ground limestone and can be manufactured throughout the world. In addition to its use in cement and plaster, it is used

[1] Cement rock is a natural rock of such composition that when burned and ground, it will form a natural cement This cement is not so strong as Portland cement

to correct acidity in soil and in many chemical processes. Gypsum is found in layers where the waters of former lakes have evaporated. New York State is the principal American source; the principal European source is the Paris basin, hence the name *plaster of Paris*. Plaster board is made by pressing several layers of plaster around two or more layers of paper or pressed wood.

Asbestos. This remarkable insulating material is rock crystallized in such a shape that it looks like and can be used as a fiber. Most of the world's supply is obtained from southern Quebec, but present indications are that other deposits, such as those in Rhodesia and Russia, will become important competitors.

Other Building Materials. Glass, cinders, asphalt, tar, and many minor nonmetals are also used in building. Of these, glass is the only one of major importance. New forms of glass (glass tiles, bricks, etc.) have widened its use as has also the vogue for it in modern architecture. This last trend is partly a response to the demand for better lighting and partly due to the novel effects glass produces Glass sand is widely available and the production of glass can be readily increased to meet new demands.

QUESTIONS FOR DISCUSSION

1. Examine several large buildings in your neighborhood What are the principal minerals used in their construction? So far as you can determine, what is the source of these minerals?
2. Why is Pennsylvania an important producer of so many of the nonmetallic minerals?
3. Examine some of the styles of architecture that have appeared in the United States (for example, Gothic, mission, colonial, modernistic, pioneer houses) To what extent is each a response to available raw materials? the climate? cultural diffusion?

The Chemical Industries

These industries produce a huge variety of products ranging from such simple articles as common salt to complex compounds like bakelite. Within the scope of this book, it is only possible to treat a few of the many important chemicals. The following selection represents the most important and is sufficiently varied to suggest some of the geographic problems involved.

Most chemical industries require a source of raw material and a plant for converting this material into the desired form. In a few cases (such as the soda-ash plant at Syracuse, New York) both are at the same place. Usually this is not possible, for the raw materials must be mined where found, while processing plants are located where there are cheap fuel and

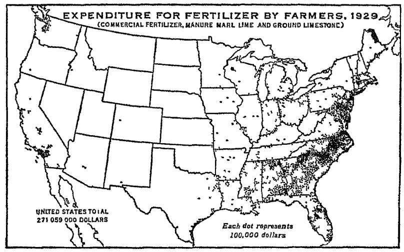


Figure 193. Note the concentration of fertilizer consumption in the South and in the sandy vegetable-producing areas. (Courtesy of the U. S. D. A)

highly skilled labor. Except for some staple commodities (as sulphuric acid), it is advantageous to locate the chemical plant near the market, since the nature of the demand often changes rapidly. The unstable and even explosive nature of many chemicals also adds to the pull of the market as a locating factor because of the risk in shipping.

The Fertilizers. This group of minerals represents the simpler phases of the chemical industries. The formulas and processes used involve no great chemical skill. Usually the minerals are brought in bulk to some convenient center and mixed in such proportions as suit the requirements of local farmers. The greatest demand for these products is found in regions of one-crop farming and exhausted soils.

Nitrates. Nitrogen is one of the most necessary elements for plant life. Furthermore, it is easily exhausted from the soil, hence the tremendous demand for nitrates by farmers throughout the world. This demand is supplied by leguminous plants, by manures, and by the application of chemical fertilizers. Nitrates are also an important ingredient in most explosives and in many chemicals.

Huge deposits of salt and sodium nitrate (Chilean saltpeter) occur in the Atacama Desert of northern Chile. Formerly, this was the world's principal mineral source of nitrates. The Chilean Government used this apparent monopoly as a major source of revenue, and farmers throughout the world supported the Chilean treasury. However, chemists discovered how to obtain nitrogen from the air by the use of an electric arc, by the *cyanamid process* and by the *Haber* (synthetic ammonia) *process*. In recent years, only 20 per cent of the world's nitrate, on the average, has come from Chile, the remainder has been produced by electricity or as a by-product of chemical industries.

The principal producing countries today are naturally those which have well-developed hydroelectric power and a knowledge of chemical techniques. Germany is outstanding; Norway, Sweden, France, Switzerland, and the United States are also important.

Potash. Like nitrates, potash is an important fertilizer and was almost a natural monopoly. Before the World War, Germany possessed most of the high-grade potash deposits. During the war inferior deposits in western United States (California and Nebraska) were exploited, but the reentry of German potash into the market caused a sharp decline of the American industry. After the war the Alsatian part of the German potash fields was given to France, and today both Germany and France are important potash producers. Production in western United States has also revived and other deposits have been utilized in Spain and Russia. Thus the German potash monopoly has been broken by changing boundaries and by exploiting the environment in other lands.

Phosphates. Phosphates are the third essential mineral used in most "complete mineral fertilizers." Large deposits of phosphate rock are found in Florida and northern Africa (Tunisia, Morocco, and Algeria) These two areas account for most of the world's production. Phosphate rock is also found scattered in many places. A substitute for phosphate rock is the slag obtained from European blast furnaces. European iron ores contain considerable quantities of phosphorus which combine with the limestone slag to make a phosphate which has considerable fertilizing power.

Salt and Soda Ash. Common salt (sodium chloride) is the source of a whole group of chemicals (including chlorine, hydrochloric acid, soda ash, and caustic soda) which are of major importance in the chemical and food industries. Salt may be obtained by evaporating sea water or by mining rock salt. Salt is a necessary element in the diet of men and animals, consequently the industry is almost as widespread as man. In those primitive countries where it is scarce it is often used as money, for anyone is glad to accept it as legal tender. Frequently it is heavily taxed by governments, for higher prices do not greatly diminish its use.

In addition to its use as a condiment and preservative, salt has many uses in industry. It is the source of chlorine, which is a strong bleach and disinfectant. Other common products, like baking soda, are obtained from salt. The salt used in American industries is obtained largely from rock-salt deposits such as are found in New York, Michigan, and Louisiana.

Sulphur. Sulphur is commonly found in the neighborhood of volcanoes and is often in pure form. Of this type is the sulphur obtained from Sicily, formerly the world's largest sulphur producer. At present, Texas and Louisiana produce the bulk of the world's sulphur. Sulphur is also obtained as a by-product in the smelting of sulphide ores such as iron and copper pyrites. Usually this by-product sulphur is marketed as sulphuric acid.

Sulphur has a wide variety of uses: it is an important ingredient of gunpowder and vulcanized rubber; it helps to convert woodpulp into paper, and cellulose into rayon; it helps to refine petroleum, and to prepare fertilizer for the farmer. Aside from its manifold chemical uses, it is important as a fumigating agent in agriculture and hygiene.

Other Chemicals. Among the other chemicals are iodine (largely a by-product of Chilean nitrate), bromine (obtained from sea water and salt deposits), borax (from dried-up lakes), fluorine (used in the glass, enamel, and steel industries), and magnesite (used in special cements). These are but a few of the hundreds which might be mentioned. Chemists are discovering new uses for them every day and some of the obscure minor minerals of today may be major minerals tomorrow. The importance of mineral fertilizers is a development of the last few centuries and the widespread use of concrete and cement is equally recent. All of this suggests that as yet man may have realized only a small part of the possibilities of his chemical environment.

QUESTIONS FOR DISCUSSION

1. Southern seaports, such as Charleston, are important centers for the manufacture of mineral fertilizers Why?
2. Why are mineral salts so often found in desert regions?
3. Why is the area from New York to Wilmington, Delaware, so important in the chemical industry?

REVIEW QUESTIONS ON CHAPTERS 26 TO 31

1. Check list of new terms:
   paraffin base, asphalt base, mixed base, fossil domes, anticline, oil pool, gusher
   pipe line, tanker, tank car, cracking
   peat, lignite, bituminous, anthracite, coking coal
   coal seam, open cut, dip
   overcapacity, overproduction
   ore, placer deposits, primary deposits
   magnetite, limonite, siderite, hematite, scrap, native copper, bauxite, alumina, galena
   smelt, concentrate, refine, blister copper, flotation
   economic geology, cement, concrete, ballast, bedrock
   facing, natural monopoly
2. What minerals are most likely to be subject to monopolistic control?
3. Outline the conservation problem for: coal, petroleum, iron, copper, water resources, soil resources.

Part Four: COMMERCE AND MANUFACTURING

CHAPTER 32

COMMERCE, PORTS, AND WATER TRANSPORT

COMMERCE is defined as "the exchange of commodities." It results from the existence of local deficits of certain commodities which can be supplied from the surpluses of other areas. Each commercial transaction involves both a buyer and a seller, each of whom exchanges a commodity of which he has a surplus for a commodity which he desires. (The commodity obtained by the seller may be money which represents gold, silver, or some other staple which is universally desired.) The amount of commerce depends, therefore, first, on the intensity of a people's desire to consume and, secondly, on their ability to produce surpluses of some commodity which can be exchanged for the desired goods.

Consumption. Demand, both for necessities and for luxuries, varies considerably from place to place. In the tropics the absolute necessities are few; there is need for little clothing and shelter; even the food required is only about three-fourths the amount needed in the temperate zone and half that needed in polar regions. In middle latitudes, however, men require more food, warmer clothing, more substantial houses, and some provision for heating, and to obtain them, the inhabitants must produce more than the peoples of the tropics.

The demand for luxuries also is higher in the middle latitudes. Activity is stimulated by pleasant weather and cool temperatures and there is a consequent desire for more than the minimum requirements for existence. In contrast, tropical temperatures discourage any activity beyond that necessary to make a bare living.

The demand for both luxuries and necessities is, consequently, greatest in the temperate zones, and trade there is likewise more extensive. Figure 195 provides illustrations of these statements.

Increased consumption may be caused by social and political movements such as the "Westernization" of Japan, the rise of Fascism in Italy, and the growth of nationalism in many of the newer European states. On the other hand, religion may play the opposite part, as peoples who put most value on "treasures in heaven" may have less incentive to seek more comfort here below. This may be especially strong in those religions which teach that the greater the hardship in this world, the greater the glory in the next, or, as in Mohammedanism, that everything is predetermined, hence struggle and planning are of no avail.

Production. A strong desire to consume is, of itself, not enough to cause production. Many peoples *appear* to be satisfied with low standards of consumption, whereas, actually, the low standards are due to environmental and other handicaps which make the peoples unable to produce. This is undoubtedly a part of the explanation for the low standards of many Asiatic peoples, especially the Chinese. China has such a crowded population, and the struggle for bare existence is, therefore, so intense that the average peasant is able to produce little beyond the bare necessities. Here, also, the lack of a stable government, poor transportation, lack of capital, and many other factors contribute to the general poverty. Certain it is that the Chinese, like the peasants from Eastern Europe, are willing to work long and efficiently for the rewards which are available in countries which have greater resources per capita.

The close dependence of consumption on production can be seen plainly in the foreign trade of many small political units. Consider the trade of Gold Coast which exports chiefly cacao beans (Fig. 194).

It is evident that the value of the imports fluctuates with the value of the exports. Occasionally there is a lag of one year because of unexpected price changes but, on the whole, the relationship is close. Similar relationships exist throughout the world but are not always as evident because of the more complex conditions in the larger and more diversified areas.

Cultural Differences and Trade. The rate at which inventions and discoveries are made differs from people to people and from age to age. Such

Figure 194

FOREIGN TRADE OF GOLD COAST

(in 1,000's of pounds sterling)

Year	Exports	Imports
1924	8,715	7,207
1925	9,786	8,821
1926	10,999	8,444
1927	13,459	11,703
1928	12,944	11,302
1929	11,531	9,626
1930	8,855	8,507
1931	6,504	4,434
1932	6,329	5,350
1933	5,956	5,096
1934	5,428	4,390
1935	6,605	7,376
1936	9,190	8,531
1937	12,036	12,307

differences in ways of doing things often lead to trade. If one tribe develops a weapon or a skill in working materials which is superior to that of another tribe, barter may spring up. Often these differences are partly or wholly independent of environmental differences. In modern times, for example, Paris has enjoyed great prestige for its millinery, dresses, bric-a-brac, and other articles of decoration and fashion. The basis for its exports is almost entirely cultural. For nearly a century, the British traded their manufactures for raw materials and foodstuffs from all parts of the world. Their advantages lie not so much in raw materials and power but in their priority in industrial development with the consequent prestige and leadership which followed.

Such trade based on differences in culture is, in many respects, precarious. Culture spreads rather rapidly, and the rise of the United States, Germany, Russia, Italy, and Japan to industrial eminence has indicated that such cultural differences tend to iron themselves out, thus destroying whatever trade is based on them.

Many other cultural factors—such as weak governments, tariff barriers, legal restrictions, lingual differences, boycotts, and wars—discourage trade. The discussion of each of these factors in detail belongs to economics and political science rather than to economic geography. Nevertheless they must be considered constantly in analyzing the geography of commerce.

Transportation—The Means of Trade. No matter how favorable other factors may be for trade, commerce is extremely difficult without the proper transportation facilities. Many of these facilities are so commonplace that it is easy to overlook the tremendous capital investment they represent. Even the building of a raft or the cutting of a narrow trail through the forest, probably among the simplest of transport facilities, represents a considerable amount of labor. Because the possibilities of the division of labor increase with the size of the market, it is patent that increasing the transport facilities increases the extent of the market and makes possible further division of labor which, in turn, brings about more trade.

The Bases of Trade. Before proceeding, it may be well to sum up those factors which favor trade between two areas:

1. The peoples of both areas should have a great desire to consume and to produce.
2. Both areas should have resources, but these should be different (although the difference may be slight) in each area.
3. There should exist ample means of transportation and communication.
4. There should be no considerable barriers to trade, such as high tariffs and embargoes.
5. The people of each area should be friendly to the people of the other area

Actually, all of these requirements are seldom present to a favorable degree, but the extent to which they are present will tend to determine the intensity of the trade between the two peoples.

The Location of Trade Routes. Do trade routes arise from economic activity or does economic activity arise from trade routes? An examination of economic history will show that either may be causal Areas already economically active attract traders and consequently encourage the establishment of new trade routes as soon as new and better means of transportation are available. Thus, the perfection of the airplane and airship led to the establishment of air lines between the established centers of activity, although these lines often paralleled old-established water and overland trade routes. On the other hand, many roads and railroads have been built both by government and private capital in anticipation of the economic activity and trade which would develop when routes were available. Of this, perhaps the best example is the building of railroads in the American West during the middle of the nineteenth century.

The basic principle is that trade routes connect centers of economic activity. Several corollaries follow. For example, the most intensive economic activity occurs in industrialized areas, hence it follows that the principal trade routes are those connecting two or more industrial centers. Conversely, trade between

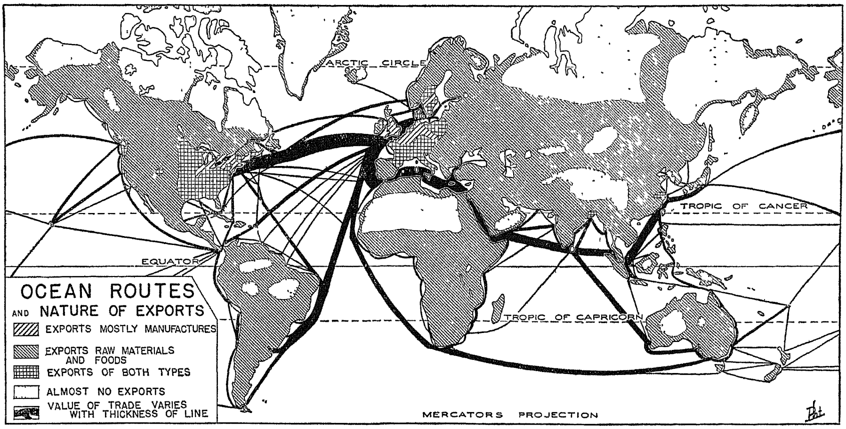


Figure 195. Compare this map with the occupations map (p. 15) and with the population map (inside rear cover). The export areas are, necessarily, highly generalized

two nonindustrialized areas is usually of minor importance. Between these two extremes are those routes which connect an industrial center with a nonindustrialized area that provides the former with food and raw materials Thus the ores of Mexico and Peru, the grain of Argentina, and the rubber of the East Indies are carried to the industrial regions over busy trade routes. These routes, and often the goods they carry, are the result of the initiative of the industrial centers, which provided capital, management, techniques, and means of transport.

The second general factor is the cost of transport. On a featureless plain, the shortest and cheapest route is a straight line between the points of activity. But there are few such ideal situations and often the longer way is the cheaper way. Indeed it may be cheaper to depart by hundreds of miles from a straight course to avoid mountains in which the cost of route construction and maintenance is high, and the requisite power is disproportionately great. A body of water across the path of a land route may force a great detour in order to find a place where a crossing may be made cheaply. On water routes, rapids and shallows may force detours or constant transshipment, so that the route suffers in competition with some other which may have greater distance but lower transshipment costs. The ancient caravan routes across Asia avoided the Gobi Desert as much as possible and kept near the foot of the mountains because, there, water was more available. Snow, washouts due to torrential rains, sandstorms, the prevalence of storms, and the prevailing directions of winds at sea are some unfavorable phases of climate that may cause a trade route to deviate from an ideal course.

The third factor determining a trade route is the need for supply stations. These are now somewhat less important than in the past Formerly steamships were slow and burned large quantities of fuel in proportion to the distance traveled, thus necessitating frequent stops at coaling stations. But, although recently larger and more efficient conveyances have made transportation generally more flexible, the supply station is still an important factor, especially in unsettled areas. The camels in the caravan must be assured frequent supplies of water, automobiles must stop for gasoline, cross-country busses must make lunch stops at regular intervals, airplanes must refuel, and even large liners still depart occasionally from the shortest course to obtain fuel at a low cost. For example, boats from New York to eastern South America stop at Trinidad because of the cheap fuel-oil supply obtainable from the local industry.

Stops at places off the direct route are often made to pick up additional passengers or freight. Once the initial cost of the journey between terminals is borne by the through freight, a comparatively small additional cargo may justify the carrier in departing somewhat from the most direct line, unless high speed has

been the chief inducement to the through traffic. Thus, the slower passenger boats en route from New York to Europe will schedule a stop at Boston or Halifax if there seems to be enough demand.

QUESTIONS FOR DISCUSSION

1. What is the relation between the standard of living and the resources in a region?
2. How is the foreign trade of the United States affected by the seasons?
3. The foreign trade per capita of the United Kingdom is greater than that of the United States. Why?

Water Transport

Ocean Transport—A Free Highway. Ocean transport is much cheaper than overland transport, largely because the right of way on the ocean is supplied by nature, free. There are no construction costs, no taxes, and no upkeep. Furthermore, the capital invested in the carrier is less per ton of freight than in any form of land transport. The terminal charges, insurance, labor, and power used per unit of freight are also less

In the places where ocean transport bears some of the costs common to overland transport—that is, in restricted bays, river mouths, or canals—the expense mounts because the right of way may have to be surveyed, dredged, and lighted. These costs are usually collected from the ship operators in the form of canal tolls, port fees, and pilotage charges. But, as a rule, these charges are much smaller than the taxes and license fees paid by railways, busses, and trucks operating over comparable distances.

Ocean Carriers. Cargo is carried across the seas by three types of service, each with its own type of vessel. Best known are the liners—fast vessels built to carry passengers, freight, and mail. The tramp steamers, vessels chartered for special trips, are generally smaller and slower than the liners; they are built primarily for the cheap carriage of bulky cargoes rather than for looks or speed. The most recent type is the industrial vessel, owned by large industrial corporations, and constructed especially to carry its products.

Line Services. The liners operate on regular schedules which are usually maintained no matter how small the cargo or how few the passengers. They offer fast and often luxurious services to those who can afford to pay for them. Although their schedules and rates vary with the seasonal demand, information about them is available to the exporters well in advance. Services of this type require a huge capital investment for they involve the operation of a fleet of ships, the opening of numerous offices and agencies, and the financing of expensive advertising campaigns.

Line services can only be maintained between ports whose trade is fairly regular. On the other hand, the presence of a dependable line service encourages the development of trade. Partly for this reason, government subsidies, either in cash or as mail contracts, are commonly extended to steamship lines both to develop new trade routes and to maintain established services. Such government subsidies also insure the construction of a speedy merchant marine suitable for transport services during wars.

The Tramp. Much of the world's freight is carried by the lowly cargo "tramp" which operates on charter rather than schedule. That is, it goes where cargo is to be had and takes it to the place where it is wanted, regardless of distance or route. It then tries to pick up another cargo in the vicinity for the return trip.

The basic determinant of the route is, of course, the amount of freight to be had. Other factors influence the route, however. Freight rates are cheapest, usually, to ports where the chances of getting a return cargo are good. This does much to concentrate traffic in few ports rather than scattering it among all ports having shipping facilities. The chance of getting a return cargo or partial cargo may also determine the choice of routes. The distance from England to the ports of Chile is somewhat shorter via the Panama Canal than down the east coast of South America and through the Strait of Magellan. The latter route is often favored by British ships, however, because the east coast of South America has more population and trade, with the consequent chance of getting cargo. If a British boat is sent for a cargo of nitrate or copper to Chile, her agents immediately look around for freight to be taken to Rio de Janeiro, Montevideo, or Buenos Aires.

The availability and cost of fuel also has a marked effect on the detailed route followed. The Mediterranean route, for example, has numerous fueling stations where fuel is cheap. In addition, cargo is much more plentiful, so that boats from New York for the Far East often go that way rather than through the Panama Canal. The constant aim is to avoid steaming any unnecessary miles with no cargo. This further tends to a cumulative growth of a few main trade routes.

Industrial Vessels. These vessels are constructed to suit the specialized needs of their owners. Thus oil companies construct oil tankers, lumber companies lumber ships, *et cetera.* Although they usually carry

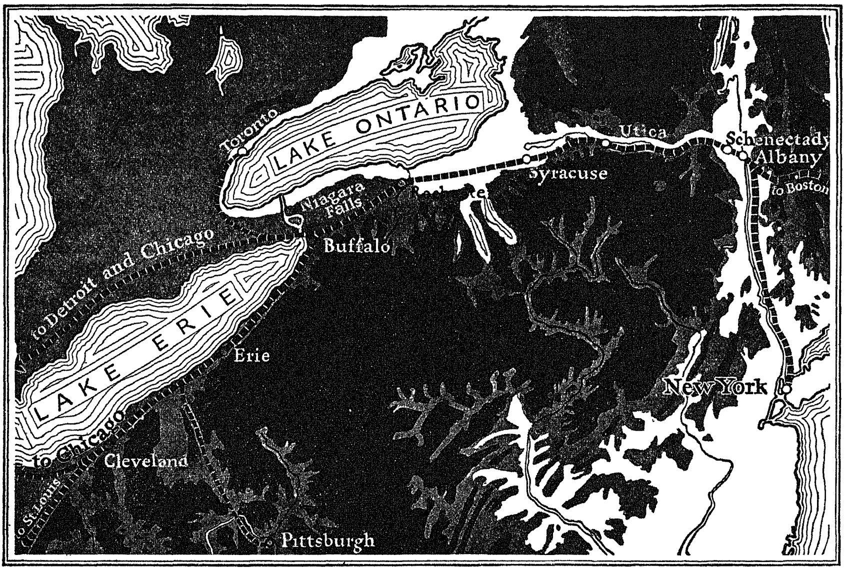


Figure 196 The New York Central Railroad advertises that it uses the only water-level gap through the Appalachians and demonstrates its point with this map. (Courtesy of the New York Central System)

freight for their owners only, a few of them (for example, the fruit company vessels) also conduct a regular line service. Some also are chartered as tramps when they are not needed by their owners.

Rates in International Maritime Trade. Ocean rates between nations, being free from government regulation, are determined basically by what the traffic will bear. This is shown most clearly in the tramp business where rates for chartering may range from barely above the cost of the voyage (or less if the tramp has a better chance of getting profitable business at its destination) to exorbitant amounts when the supply of tramps at or near a port is far exceeded by the demand.

In the line services, such unstable rates would be ruinous. In slack seasons, the competition among the lines would result in rates far below the cost of operation. No matter how low the rates, many lines would be forced to operate because of their mail contracts. To eliminate such ruinous rate-cutting, the lines operating within a certain area may form themselves into "conferences" which establish uniform passenger or freight rates For example, the Transatlantic Passenger Conference regulates the rates on the North Atlantic according to the speed of the ship, the class of accommodation offered, and the season.

Coastwise Traffic. The coastwise trade of any nation having a long coast line is of tremendous importance. It is slow, but so cheap in comparison with the land routes with which it competes that it has a very large advantage. Many nations, including the United States, reserve the coastwise trade for their own vessels.

In the United States, the trade between the two coasts is of great importance. The Panama Canal has made it so cheap that the transcontinental railroads feel the competition very keenly. Relative to this competition it is interesting to observe that the Interstate Commerce Commission has allowed the railroads to quote rates for a through haul from coast to coast lower than those for much shorter distances between inland points. The whole result of this policy has been to place a handicap on shippers of the interior as compared with those of the Pacific or Atlantic

slopes. Coastwise traffic has less tendency to be concentrated in a few ports than has ocean shipping, and there is a larger proportion of scheduled line service in this type of trade.

Inland Waterways. Large lakes offer most of the advantages of oceans for water transport but other inland waterways have handicaps which seriously impede their use. Rarely is the right of way free for almost all inland waterways require some dredging, straightening, and lighting before they can be put into use, and many require the construction of canals with locks and other expensive equipment. If all of these costs were charged against the shipper, his business might be unprofitable. Often the cost of the improvements is borne by the government, and tolls are nominal or absent. If the waterway is too small to admit large ships, the economy of power used in proportion to cargo is diminished. Slowness is a further handicap. In the use of large ships on restricted inland waterways with narrow channels, the danger of collision or grounding is increased. Perhaps the outstanding handicap of the inland waterway is that it is relatively fixed in direction, while overland routes may be adapted to changes in location of freight.

Inland waterways have been of special importance in the opening up of new regions. While it is true that lights and dredging are necessary for an inland waterway system that is to compete with railroads, nevertheless small boats can often navigate unimproved waterways if certain precautions are taken. Such transport in the Amazon Valley, the Mississippi Valley before the Civil War, and Siberia has proved far cheaper than building roads and railroads because it required little capital investment.

QUESTIONS FOR DISCUSSION

1. Which would you expect to find more common on the great ocean routes, the liner or the tramp? Why?
2. Why is ocean transport usually cheaper than land transport?

Ports and Harbors

Ports are the connecting links between water and overland transport. If possible, ports are developed around good harbors. Because it is not always easy to find good harbors in appropriate positions, many ports are developed which have mediocre or even poor sites.

Physical Aspects of a Good Harbor. The ideal shape for a harbor is roughly that of a bottle. The entrance, although wide enough to accommodate the traffic, should be narrow enough that storms do not greatly disturb the waters within. One of the best harbors in the world, so measured, is that of Rio de Janeiro. Not only is it almost completely surrounded by land, but this land is high enough to shelter its shipping from storms from almost any point of the compass (Fig. 197). New York's harbor is nearly as favorable, for the hills of Staten Island and Long Island give the inner harbor almost complete protection from winds from the sea.

Peninsulas jutting out into the main harbor multiply the pier space available and permit a great deal of traffic to be concentrated in a short distance. A fine harbor in this respect is that of Halifax where a peninsula, amply large enough for the city and all the necessary dock space, juts out into the harbor and allows the maximum of dock space to be concentrated within easy reach of railroads, custom house, and warehouses. Islands in the harbor increase the pier space, but make land communication between the units difficult. This is one of the main handicaps of the port of New York in these days of tremendous land traffic.

Depth. Deep water is required, not only in the middle of the harbor, but nearly up to the shore. Perhaps the ideal condition would be a gradual deepening which would give a depth of forty-five feet or more at the end of the piers, but would not give such great depths that piers could not be constructed cheaply. Dredging between piers to get an appropriate depth is preferable to water so deep that it is too expensive to build piers.

Proper depth is, of course, a relative thing. One of the reasons why many American rivers which were once traversed by ocean-going vessels are now in disuse is that the depth of water required by such vessels has increased greatly. Such cities as Richmond, Virginia, and Hartford, Connecticut, were once directly connected by ocean-going vessels with all the ports of the world; but the increasing size of ocean carriers relegated them to the position of river ports. This was true even before the passing of sail as the principal motive power and is more than ever so now.

Tide and Currents. A considerable rise and fall of tide is usually a disadvantage to a harbor. During low tide there may not be depth enough for traffic. The currents arising from the excessive rise and fall of the tide, in themselves, render the handling of boats difficult and dangerous. It is true, however, that these same currents may be strong enough to prevent silting up at any narrow points in the harbor. Although the tidal variation at New York is not great, it is sufficient to scour out the channel at the Narrows and in the North and East rivers four times a day.

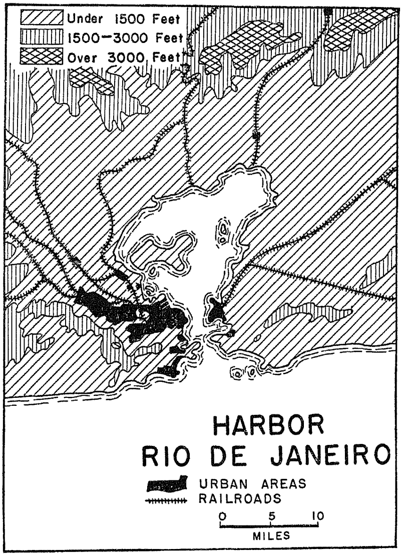


Figure 197.

A wide range between normal high and low tides gives rise to a unique type of port development. In the British Isles, where the normal variation is often twenty feet or more, the tidal basin is almost a necessity In this type of port improvement, a basin is constructed with piers completely inclosing it. At high tide, ships arrive and depart. As the tide begins to fall, the locks are shut and the water within the basin remains at the high level. It is impossible to enter or leave except for a very short time twice a day. Such developments have been necessary at London, Bristol, and many other English ports. At Bristol, where the river connecting the port with the sea is very narrow, the river is completely locked off at the end of high tide, and the whole port back of this lock proceeds about its business. On the other side of the lock, the channel is a mere trickle of water through mud flats some forty feet below. The expense and inconvenience of this type of port are obvious.

Climate. The prevalence and average direction of storms at a given harbor may affect its usefulness to a marked degree. A wind off the land is much less dangerous than one off the sea. In the open roadsteads along the west coast of South America, where there are no good natural harbors, storms off the sea are common. The ships lie off the towns and discharge to lighters. If a storm comes up, the ship must interrupt its unloading and beat out to sea. It would be dangerous to try to ride out an onshore wind so close to shore, and the swell would interfere with the handling of the lighters. On the Pacific coast of the United States the storms are from the southwest, and in such open harbors as that at San Pedro (Los Angeles) may be a considerable disadvantage.

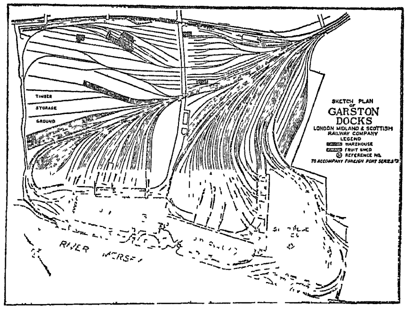


Figure 198. Tidal basins in part of the port of Liverpool (U S Department of Commerce)

Fog is another climatic handicap. The ports of the British Isles, Montreal, Boston, and San Francisco suffer from this handicap

A winter climate severe enough to cause freezing is also a real disadvantage. Perhaps this is most notable in the Baltic ports in Europe. Russia's interest in the Pacific port of Vladivostok and the Manchukuoan ports is due in part to this handicap in its other ports

Relief. It is advantageous to have large areas of flat, firm land adjacent to the harbor edges. This allows space for the growth of all the facilities of a port, and gives room for manufacturing and residential developments. Many of the smaller Norwegian ports have everything that could be demanded of a harbor but this feature. Because deep fiords penetrate a mountainous country, their sides are so steep that town building is difficult. The outstanding example of this limitation in North America is Prince Rupert, British Columbia, which is the Pacific terminus of the Canadian National line from the prairie provinces. Here, the harbor sides are so steep that the town is built on a number of levels and there is little room for piers.

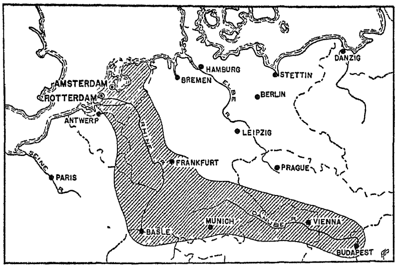


Figure 199. The hinterland (shaded area) of Rotterdam and Amsterdam as estimated by the U. S. Department of Commerce Where do you think the hinterlands of Antwerp and Hamburg are located?

Another important aspect of local topography is the ease of access from the harbor to the surrounding country. If high hills rim the harbor without a break on the landward side, the harbor will be of little commercial use. An example of the difficulty arising from this handicap may be seen on the New Jersey side of the Hudson River opposite New York City. For a long distance the Palisades rise so abruptly from the water front that it is only with the greatest of difficulty and expense that this frontage can be used at all.

Seaports on Rivers. Rivers form the harbors of some of the world's great ports: Hamburg, London, Liverpool, Philadelphia, New Orleans, and Montreal are but a few of them. In most of these, difficulties of protection do not arise. Their principal problems are those of maintaining deep channels and providing room enough for the shipping of the port. This latter necessity leads, in many instances, to the construction of basins, dug out of flat land or marshes to provide more pier space. Hamburg and Antwerp are examples of ports that have constructed hundreds of acres of such basins. These basins may or may not be closed, depending on the tidal variation.

Position and Port Development. A physically perfect harbor will not necessarily develop into a port unless it is on a world trade route. In many areas where ships must anchor far offshore in an open roadstead, considerable trade is carried on. However, if two equally well situated harbors are competing, the physically best harbor will become the major port. Likewise, if two equally good harbors are available, the best situated will be most rapidly developed. The port of New York provides an excellent example of the influence of position in port growth.

The Port of New York. As settlement grew in the thirteen colonies, a number of ports grew up at places where the sea was most accessible from the widest area of back country. Boston was the hub of the New England settlements and had the best harbor available to these settlements. New York served that country drained by the Hudson; Philadelphia gathered in the trade of the Delaware and some of the Susquehanna Valley. Baltimore, Charleston, and Savannah performed similar functions for their tributary areas or *hinterlands*. During all this time, settlement was confined to the area east of the Appalachians. These cities were nearly equal in population and trade, as each had hinterlands of somewhat similar size and value.

Then, as population spilled over the mountains and began to develop the riches of the interior, each of these ports attempted to reach back and bring some or all of this trade within its influence. Boston, New York, Philadelphia, and Baltimore businessmen talked of canals to connect their cities with this new territory. Boston found herself with two uplands to cross and a canal was impossible. Philadelphia built her canal, but had to overcome the Appalachians with a railroad. Baltimore never completed her canal beyond the insurmountable barrier of the mountains.

New York, alone, had a practicable canal route to the West, and built the Erie Canal from the Hudson, by way of the Mohawk Valley, to the Great Lakes at Buffalo. This canal was, for several decades, a route of tremendous importance. A great part of the trade of the interior centered on New York and soon made that city the greatest port in the Western Hemisphere. Other cities had as good harbors, but New York alone had easy access to the traffic. The trends of trade set by the Erie Canal continued through the subsequent dominance of the railroads and persist today.

The size and importance of the related *hinterland*, and the parts of the world with which a port has contact, are the principal determinants of its size. The Elbe drains a larger active area than the Weser, making Hamburg a greater port than Bremen. The Rhine routes give Amsterdam and Rotterdam their importance. The Mississippi makes New Orleans a greater *port* than Mobile or Pensacola, though the *harbors* of the latter are better than that of New Orleans.

The Head of Navigation. Water transport is cheaper than land transport, hence it follows that ocean routes will penetrate the land as far as possible before the goods are turned over to the more ex-

pensive land transport. Thus the head of navigation on a river is more likely to become an important port than even a fine harbor on the tip of a peninsula. This principle is responsible for the importance of Montreal, New Orleans, Hamburg, London, and many other ports. There probably is not a better physical harbor in the world than Halifax, Nova Scotia, yet most of the trade of Canada seeks ports farther inland Montreal in summer, or St. John, New Brunswick, in winter. Likewise Brest and Cherbourg bow to Bordeaux and Havre, and Lewes and Cape May to Philadelphia.

Rate Structure. The influence of distance is often modified by the adoption of arbitrary freight rates, which, for competitive reasons, disregard certain geographical handicaps. Thus, it is possible to buy a steamship passage from New York to Hamburg by the way of Oslo, Norway, for the same fare as would be charged to go by direct boat. Railway freight rates to competing ports are usually the same in spite of great variations in distance. Thus the businessman does not consider geographical position in allocating his business unless it affects his freight bill, makes uncertain his deliveries, or lowers his sales. These factors are often important in determining his choice between ports, but minor differences in position are often made ineffectual by the rate structure alone.

The Entrepôt and the Free Port. The growth of trade is cumulative. Once a port has attained commercial leadership, it can offer more and better connections. This advantage attracts still more trade, which is drawn to large ports because they serve as *entrepôts,* that is, ports which reship the goods received.

The services of the entrepôt can be illustrated by the case of a gun manufacturer located at Bridgeport, Connecticut. He enters the export field, and obtains an order for one hundred shotguns from Singapore, and another hundred guns from Yokohama. If he waited for a ship going from Bridgeport to either or both of these ports, he might wait a considerable time. He cannot, of course, afford to charter a tramp steamer for so small a quantity. Therefore, he ships his guns to New York, because he knows that the desired ships will be leaving that port every few days. He not only has all the line services from New York at his service, but also a great number of tramp ships which may be looking for a mixed cargo for Asiatic ports. Thus the entrepôt has a special advantage for handling less than cargo lots.

Almost any large port performs some entrepôt services for smaller ports, but there are a few outstanding world entrepôts. New York, London, Rotterdam, Amsterdam, Antwerp (Anvers), Hamburg, Marseilles, Singapore, Hong Kong, and Yokohama are among the largest of these.

Many entrepôts offer the advantages of a customs-free zone and are therefore called *free ports.* Such ports are not entirely free; they levy port dues, pilotage charges, and land taxes. But the free-port zone is not considered within the customs limits of the country which controls the free port. Within it, goods may be imported, warehoused, traded in, manufactured, and exported without any customs formalities as long as they do not move beyond the boundaries of the free zone. This saves a great deal of time and bonding expense. Hamburg has a model free port and has developed a great industrial center within it. The bonded warehouse performs somewhat the same functions in the United States. But the bonded warehouse involves considerable inconvenience, and New York has established the first free port in the United States on Staten Island.

Entrepôt trade is less important than formerly, especially in the export trade, for the exporter tends to ship his large shipments through the nearest port by tramp or liner. Moreover, special facilities have grown up for handling specialized commodities such as grain, coal, and iron ore. However, in the import country, a commodity is more likely to be handled as an entrepôt transaction. Although the producers may ship out full cargoes, few consumers can use a shipload at a time. Furthermore the commodity may need processing or temporary warehousing. The import entrepôt performs all of these functions.

QUESTIONS FOR DISCUSSION

1. Outline the site factors for some sea or lake port with which you are familiar.
2. Draw a map showing the ideal conditions for a good harbor. In what parts of the world would such harbors be likely to be found?
3. Does an excellent *harbor* necessarily grow into a great *port*? Explain. Can there be a great port without many of the physical aspects of a good harbor?

CHAPTER 33

TERMINALS, LAND TRANSPORT, AND TRADE ROUTES

THE PRODUCE of a region must be concentrated at certain focal points if it is to be transported efficiently to distant markets. If no such concentration were effected, the world would be covered with a network of routes connecting every producer with the markets for his goods. Under such a system, transportation would be so expensive that little trade would be carried on except within local areas, and the benefits of the geographical division of labor would remain unrealized. By trial and error, however, a system of fairly well-established world trunk routes has been developed, usually by combining convenient sections of earlier local routes.

The world's routes may be divided into three classes:

1. The major trunk routes which usually connect important terminal cities
2. Branch routes which extend from terminals, or from junctions with the main trunk route, into the hinterland and act as feeders to the trunk routes
3. Strategic routes, including military roads, scenic highways, and the like, which are developed without consideration of their possibilities as carriers of goods.

Of these, the major trunk routes are usually the sea routes or those overland routes which drain the trade of the interior toward the ports. The branch routes are largely overland routes Just as the size of a river depends on the number and volume of its tributaries, so the importance of a trunk route depends on the branch routes which join it.

The nature of the overland routes strongly influences the location of the extensive economic margin. Let the cost of transportation to the market decrease and the profits of the farmers will tend to increase proportionately. The same principle operates in all businesses into which transportation costs enter, but is most important in businesses which ship bulky or heavy goods.

Overland Transport

Trails and Roads. The existing network of roads and trails is an index of the thoroughness with which man has occupied an area. Even in the most primitive societies, by continued use if not by intention, certain pathways are worn through the forests and across the grasslands. Even animals customarily use the easiest way and wear trails to the sources of food and to the water holes. In a modern exchange economy, the simple trails and roads are overshadowed by the major ocean routes, the inland waterways, and the railway net, yet the bulk of the traffic originates on the side roads which feed the trunk lines.

Roads and Vehicles. Although a simple path suffices for the pedestrian, a well-built road, often costing ten thousand dollars per mile, is desirable for the fast interurban busses and trucks. A geographic study of a highway system is almost meaningless without a consideration of the vehicles that use it. The surface, width, curves, and gradients of the route are eventually regulated to suit the common vehicles, which in turn are influenced by engineering progress and the kind and amount of traffic. As the traffic becomes adequate to justify additional capital investment in routes, the world's highways become better surfaced, straighter, wider and—through tunnels and bridges—more level than their predecessors. Thus, better vehicles and better routes combine to reduce the effects of distance. On the other hand, those regions which are unproductive often remain isolated and are served by the most primitive routes and vehicles long after these have disappeared elsewhere.

Roads and the Natural Landscape. The construction of even the simplest trail is often expensive in terms of labor. If anyone doubts this, let him try to construct a simple blazed trail through a forested area. Blazing the trees, clearing the underbrush, selecting the shortest or easiest route, all take time and hard labor. In a flat grassland or desert area the task may be simpler, but even here stones must be found to erect cairns for markers, water holes must be available if the trail is long, and favorable stream crossings must be taken into account. Nevertheless, some landscapes are obviously better suited to routes than

others, and if the demand for a route exists, the road builder usually follows the easiest way.

The natural landscape often influences the density of the road net. In a rugged country, there are usually a few well-built routes which conform closely to the main valleys and passes, and a number of inferior side roads up the smaller valleys. A plains country often has a multiplicity of through routes, paralleling and crossing each other, and the many side routes are of fairly good quality. Low costs of construction per mile and great traffic per square mile permit a larger number of roads to be of high standard.

Motor Vehicles. The superiority of trucks and passenger automobiles lies in their flexibility. Although paved highways encourage their use, they can travel on wagon roads and, in treeless regions, dispense with roads entirely if the surface is not too rough. Consequently the automobile frequently appears before the railroad in backward regions.

Nevertheless, automobiles are more numerous in the highly developed commercial and industrial areas. Of the 35,000,000 motor vehicles in the world, more than 25,000,000 are in North America and 6,000,000 in Europe. Within these areas, they perform services roughly comparable to those of tramp steamers in the sea trade. They operate on charter for specific tasks whether they serve as taxis, moving vans, or freight carriers.

In recent years, motor vehicles have successfully competed with railroads on regular line schedules. Where the law does not forbid competition with the railroads, regular bus and truck services operate about as dependably as trains Because of the great network of roads and because only a small capital investment is required—capital which may easily be shifted elsewhere if an enterprise does not succeed—the growth of motor service has been rapid.

Railroads. In contrast, a railroad requires a huge initial capital investment. A mile of well-ballasted track suitable for a modern streamlined limited may cost as much as a million dollars if the topography is unfavorable. To the cost of the track must be added large amounts for stations, telegraph lines, locomotives, and cars. The initial investment is so great that only governments or large corporations can finance a line of great length.

Decreasing Costs. At best the tremendous capital investment means that the railroad has a large amount of fixed charges (overhead) which accrue no matter how many passengers or how much freight is carried For example, the cost of operating a passenger train is only slightly increased if the number of passengers is doubled, yet the expense of track maintenance and other fixed charges continue even if the train is discontinued.

A railroad is, therefore, a prime example of a business operating under *decreasing costs,* that is, each additional unit of business can be handled at a lower cost than the preceding unit This condition has an important effect on railroad rates, which are (or should be) adjusted so as to bring the highest total profit rather than the highest price per mile. Railroads often voluntarily reduce their rates when they believe such a reduction will result in a beneficial increase in traffic.

Rates. The most important rate-making principle is that the total traffic must yield more than the cost of operating the railroad. Traffic is attracted by attempting to increase the prosperity of the area served, by meeting the competition of other carriers, and by varying the rates according to the type and quality of service rendered. These factors are considered in determining the rate schedules submitted to governmental agencies for approval.

The methods railroads use to increase the prosperity of their territory may be illustrated by the development of commuting areas. Rates offered to regular commuters are but a small fraction of the usual rate. Passenger business increases, as does freight business when stores and industries grow in the suburban towns. Or the industrial department of the railroad may add to the growth by advertising the advantages of specific factory sites.

The competition of services offered by trucks, busses, canal boats, river boats, and coastwise steamers influences railroad rates, especially for those services which do not require speed. Express and passenger services by air tend to influence the rates of fast railway services.

Rate classification is an attempt to get as much traffic as possible. Bricks, for example, would not be shipped considerable distances by rail if the same rate per ton were charged them as is charged for automobiles. Many passengers will travel on excursion trains who would not travel at all if they had to pay the regular fares. If the additional traffic attracted by the low rates in some categories brings in more than the additional operating expenses incurred in handling that traffic, the business is worth while to the railroad even though the additional traffic may not pay any part of the fixed charges.

Rate classification is also partly due to differences in costs of handling various kinds of traffic. For example, tables assembled and ready for use are shipped 100 miles at 59 cents per 100 pounds while the same tables unassembled are shipped at a rate of 50 cents Fragile or extremely valuable goods are charged high rates, while nonperishable bulk goods are shipped at much lower rates.

Rates also vary according to distance. Thus freight rates per 100 pounds of hardware are 41 cents for 100 miles, 53 cents for 200 miles, and 74 cents for 300 miles. Lower rates per mile for long hauls are common in all forms of transport because the cost of loading and unloading usually occurs only once no matter how great the distance

Improved Railroad Services. The competition of other forms of transportation, especially motor vehicles, has forced railroads to improve their services. Trains today are much faster and more luxurious than they were a decade ago; such features as air-conditioning, reclining chairs, and lunch counters are now common. Freight service has also been speeded up, and truck competition has resulted in the free delivery of goods by the railroads to destinations away from railroad sidings.

The Distribution of Railroads. Since railroads are complicated mechanisms which must be carefully managed by people with industrial skill, their distribution and use are limited. This explains why the United States has nearly half of the world's trackage and why much of the remainder is in Canada and Europe (see Figs. 200 and 201).

The Airplane. Air transport is largely confined to use by the commercially advanced people, although they have extended their routes over the whole world. Highly organized terminals with large level areas for landing fields are necessary for any considerable operation. Highly developed weather services are also important to safety in flying.

Although, in general, air services are most largely used in those parts of the world employing the largest amounts of the older types of transport, nevertheless the airplane has been useful in pioneer regions where rugged relief or dense vegetation has retarded highway and railroad construction. Air service connects the Pacific coast of Peru with the part of Peru located east of the Andes Air transport has preceded rail service in equatorial Africa. It is also used for transporting gold from distant places in the subarctic forests of Canada and the tropical forests of New Guinea.

QUESTIONS FOR DISCUSSION

1. Why is "the network of roads and trails an index of the thoroughness with which man has occupied an area"?
2. Show how the nature of the vehicle influences the nature of the route.
3. What determines whether a railroad should go around a mountain range or tunnel through it?

Terminals and Junctions

The position factors which locate land terminals are often similar to those which influence port development. Since a large proportion of the railway terminals are also ports, it is advantageous to have the site requirements for a good harbor. In addition, a railroad terminal requires much level land for the tracks in the freight and passenger terminals and for the classification yard used in assembling freight trains. However, if the land around the terminal is crowded, many of the freight yards may be some distance from the main terminal.

Terminal and junction cities are most likely to develop: (1) where there is a change in the vehicle of transport; (2) where there is a concentration of local resources, either human or physical (center of a rich farming area, large mineral deposits, political capital, industrial center, commercial center), (3) at a crossroads or junction of two routes of importance. Almost all cities are terminals or junctions to some extent, the importance of the city often depends on the degree to which the above conditions are present.

Many cities have developed because they happened to be at a convenient place on a through line to perform some service for the railroad. Railroad junctions and repair shops generally have this influence. The end of a railroad division often develops into a small city even though this division boundary was more or less accidental and the site had no peculiar physical advantages.

Most of the world's great terminal cities were well established before the construction of the railroads. Hence, it has become necessary to establish terminals on the outskirts, or else penetrate to the central business center by spur lines using viaducts or tunnels. Often swampy areas along rivers, the sites of old city walls, and other lands not occupied by valuable buildings have been used for the right of way, and have greatly influenced the pattern of the urban railroad net. Since through lines rarely pass directly through large and long-established cities, it is often necessary to utilize roundabout belt lines to connect terminals in the same city. In most modern forms of transport,

terminal costs are a considerable portion of total freight costs.

In the newer or smaller cities the problem is not so serious. Often the railroad has been built outside the former built-up areas, but has become more central when the city grew toward and around the railroad. In other cases, the city has actually been planned in relation to the railroads and other forms of transit.

Automobile transport has terminal problems similar to those of the railroads. The urban parking problem is familiar to all Americans In many cities, large parking grounds have been established near the suburban terminals of urban transit lines to lessen this problem. Motor transport has some advantage over railroads in penetrating a metropolis through the network of streets and roads that always have been a part of the large city. Within the last decade, however, streets have often proved inadequate to handle the volume of traffic. By-passes around large cities and around business districts, through streets, and express elevated highways have been developed in an attempt to eliminate congestion.

Air transport developed after the street plan of most large cities was well developed Consequently airports must be located many miles away from the city center, and the time consumed in reaching them has discouraged the use of the airplane for shorter flights. It is probable that airports will be developed eventually atop large buildings or in other locations close to the heart of the city.

Services at Terminals and Junctions. Though at first glance the processes of loading and unloading vehicles in terminals seem simple, they are actually very complicated. Complications vary with the amount, nature, and variety of freight handled. If only one commodity, such as wheat, is handled, a grain elevator may be the sole equipment required. But usually a railway terminal and junction, such as Chicago, must have numerous passenger and freight stations, classification and storage yards, mechanical loading devices, warehouses, offices, belt railroads, repair shops, and other specialized equipment.

The junction's basic process is performed in the classification yards. Here incoming freight trains are broken up and the cars reassembled into outgoing trains. When L.C.L. (less than carload lot) freight is handled, it may be necessary also to transfer goods from one car to another. The classification process is complicated by irregularities in the flow of traffic and by the necessity of keeping careful records of each car and package so that it can be traced.

The reconditioning of rolling-stock is another major function of most terminals and important junctions. Cars and locomotives must be cleaned, oiled, supplied with water, and sometimes repaired. Oil-burning and steam locomotives must be fueled. Certain specialized equipment requires a great variety of further service: for example, refrigerator cars must be iced, livestock in freight cars must be fed and watered; and dining-car pantries restocked.

Storage is another major service. Some goods are placed in warehouses to await seasonal demands or for needed aging or processing before they are ready for market; others to await outgoing shipping facilities. It is obvious that it saves handling if storage can be provided adjacent to the railroad yards For short periods, freight cars are sometimes used for storage.

All of these functions must also be performed by other forms of overland transport. Usually, however, their terminals are not as complicated as port and rail terminals because of the smaller scale on which motor vehicles, pack trains, and airplanes operate, and also because of the less complete services they offer For example, trucks do not handle loads large enough to require a complicated reclassification of their freight at junctions; for reconditioning they may use public garages and filling stations, and for storage they use public warehouses.

QUESTIONS FOR DISCUSSION

1. Describe some terminal with which you are familiar. What problems were involved in developing this terminal?
2. May a railroad junction engage in the equivalent of entrepôt trade? Compare a bonded warehouse with a free port
3. Consult atlases, encyclopedias, or other sources, and find explanations for the importance of the following terminals. Hamburg, Denver, St Louis, Shanghai, Buffalo, Paris.

Major World Trade Routes

United States and Canada. North America includes two of the greatest trade areas in the world The United States includes approximately 3,500,000 square miles within one tariff wall, while Canada, within another tariff wall, is about equal in size although it has only one-twelfth the population. Both countries have higher standards of living than most other parts of the world and, fortunately, both are friendly to each other and carry on a huge trade across an almost unguarded international boundary. Within the same area, Europe contains thirty-two states, each with its own tariff wall. No wonder that

the international trade of Europe is so conspicuous, for it is counted at so many boundaries. But North America carries on a huge traffic which fully equals that of Europe.

Inland Waterways. The waterways of North America are important, but in the most developed areas they have given way to the railroads and highways. The only great navigable river systems are those of the Mississippi and the St. Lawrence. The Mississippi system, while it drains most of the interior between the Appalachians and the Rockies, trends in general from north to south, while the main direction of traffic has been from east to west. Some of the branches of the system, however, notably the Ohio and the Missouri, have been important in this east-west traffic. European rivers drain the trade of the interior out toward the busy Atlantic, while the largest stream in the United States, unfortunately, flows to the less active Gulf of Mexico.

The United States has one great inland waterway, comparable in importance to the Mediterranean Sea. The Great Lakes are, except for a few places, broad and deep, and large vessels use them with little delay or danger. The lakes trend in the right direction, for they connect the great agricultural and mineral riches of the Western interior with the industrial centers of the lower lakes and the East, and although transportation is blocked by ice during the three or four coldest months of the year, the annual traffic on the "Soo" Canal connecting Lake Superior and Lake Huron is greater than on either the Suez or Panama canals. The cargoes on the Great Lakes, as on most inland waterways, are heavy, bulky goods of low value in proportion to their weight.

Railroad Routes. The railroad net of eastern United States and Canada is equaled only by that of a much smaller area in northwestern Europe. The railroads are most concentrated around the Atlantic ports and just south of the Great Lakes. The heaviest passenger traffic is that along the Atlantic Coast from Boston to Washington, D. C.; the heaviest freight is on the lines from the interior to the Atlantic ports—from the Corn Belt and Middle Western manufacturing regions to Montreal, Boston, New York, Philadelphia, Baltimore, and Norfolk.

West of the 100th meridian, the rail net thins out sharply and, until the Pacific states are reached, it consists of little more than the ten transcontinental lines and a few branch lines. The traffic is largely passenger traffic, for the bulk of the intercoastal through traffic goes by boat via the Panama Canal. There is also considerable local traffic from Chicago, St. Louis, Omaha, Denver, Salt Lake City, Seattle, Los Angeles, and San Francisco to smaller cities and towns on the transcontinental routes, and vice versa.

The Pacific-coast states have a much heavier traffic than the semiarid plains and plateau states. Little of this traffic is local, however, and most of it is handled by boat. Regular, direct ship lines connect the Pacific Coast with the Orient, Australia, Alaska, eastern North America, and northwestern Europe. Many goods from the East and from Europe are shipped to Western inland points, such as Salt Lake City and Spokane, via the Panama Canal and Pacific ports, thus depriving the transcontinental railroads of part of the transcontinental traffic.

North of the 46th parallel (5° to 8° farther north in the Spring Wheat Belt of Canada), the rail net disappears, and the only important routes are the Canadian National's transcontinental line (built by the government to encourage settlement and never profitable) and two lines to ports on Hudson Bay. These latter lines are part of an attempt to ship out Canadian products via the shortest ship route to Europe. Churchill on Hudson Bay is one hundred and fifty miles nearer Liverpool than New York and is, of course, much nearer the Canadian wheat fields than any Atlantic port. Although it is expected that this route will save the Canadian farmer six or seven cents a bushel on his wheat, the route is hazardous, for Hudson Strait is frozen much of the year.

Motor Roads. The privately owned automobile has been a double-edged weapon in destroying the business of American railroads. Its owners have often ceased to use the railroads themselves, and, in addition, by demanding that the government build good roads they have paved the way for the truck competition which has taken over much of the short-haul freight business. An efficient and speedy bus service has also become possible because of excellent concrete roads and, in many cases, the railroads have abandoned minor spur lines and substituted bus and truck service. While the bus has taken many of the railroads' coach passengers, the air services have taken many of the de luxe passengers. This strong competition has resulted in a tremendous stepping up of all services, both as to speed and comfort. Meanwhile, the railroads, once a gilt-edge American investment, are now less attractive. In many pioneer regions, as in Canada and Alaska, bus and air services have been developed instead of railroads.

Latin America. The trade of Latin America is largely by sea and with areas outside America. The inland transportation facilities, whether rail, river, or

road, are largely feeders to ocean routes to North America and Europe. Except in limited areas, passenger service is slow and difficult Air services are very important in carrying those engaged in international business.

Inland Waterways. To the countries which they serve, the inland waterways of South America are of utmost importance. The amount of trade handled on them is, however, small The Amazon and the Orinoco provide routes of transport to a large district which would otherwise be inaccessible. That either river will develop any large trade in the near future seems improbable. The Magdalena, draining the interior of Colombia to the Caribbean, is of greater relative importance. This river has in the past been the only link with the sea for a considerable white population on the cool interior plateaus. Recently, air services and intermittent rail and road routes have decreased the river's importance. The only other commercially important river system is the Plate (Rio de la Plata), consisting of the Paraná, Uruguay, and Paraguay rivers. The lower part of this system is open to ocean-going boats which load at ports such as Rosario The upper part is navigated by river boats which resemble those of the Mississippi during the steamboat era. Their trade is not great but it is of tremendous importance to the people along these rivers.

Railroads. There are but three important railroad nets in Latin America. on the Pampas of Argentina, on the coffee plateau of Brazil, and the Mexican rail net There are also numerous short lines which connect ports with some concentration of mineral and agricultural resources in the interior. Examples of the latter group are the railroad from the port of Callao, Peru, to the mines of Cerro de Pasco, and the railroads from the Venezuelan ports of Puerto Cabello and La Guaira to the coffee lands on the Venezuelan Plateau. Some of these roads are interconnected, for example, it is possible to go by rail from Arica (northern Chile) to Puerto Montt (southern Chile), to Buenos Aires or to Rio de Janeiro. However, in practice, few passengers and almost no freight take advantage of these connections.

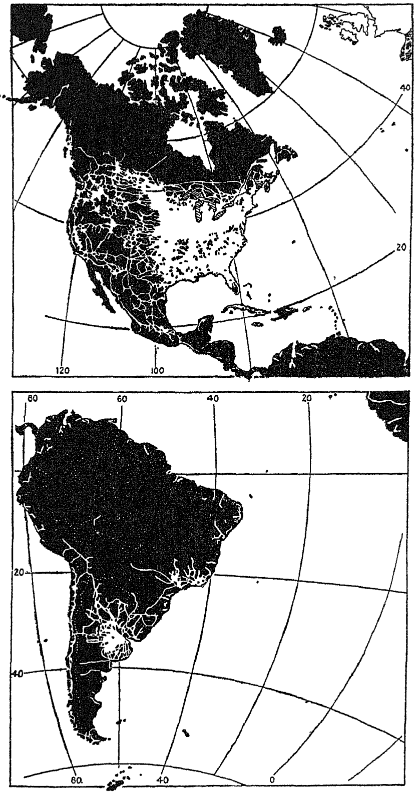


Figure 200 The white bands are 20-mile-wide strips along the railroads of 1925. (Courtesy of Mark Jefferson)

Europe. Europe is the most fortunate of continents in its natural advantages for water transport. It is almost surrounded by a series of protected seas. Of these, the Mediterranean has indentations which penetrate far into the continent, while the trade of the Black, North, and Baltic seas is fed by the traffic from numerous navigable rivers. The directions of these streams make them much more important as routes than North American rivers. The main European network of rivers radiates from a common center in the Alps, and many of them flow toward the commercially important areas of northwestern Europe. Their lower courses are through plains, and the distances between them are so short that it is easy to connect their tributaries. In fact, most of the possible canal connections were made before the development of the railroads. Add to these rivers of the northwest, the Rhone system flowing into the Mediterranean; the Danube system draining all central and southeastern Europe to the Black Sea; and

finally, the chief river of Russia, the Volga, which flows into the Caspian, and there is almost no conceivable direction in Europe that heavy freight may not be shipped by water.

Railroads. While the heavy traffic of Europe is largely handled by water, a tremendous quantity of passengers, perishable foods, and manufactured goods is carried by European railroads. The railroad net is quite thick in the countries around the North Sea but thins out very decidedly in the agricultural regions to the east and south. The speed and quality of the service also diminish away from the North Sea.

European railways are largely under government control. Invariably, they are built to focus on the political and commercial centers of each country rather than to serve as parts of through routes Often, military rather than economic considerations have determined the routes. Roundabout routes and long border stops for customs and passport examination slow down the international expresses, even on lines where good roadbeds permit fast time. Changes in political boundaries have added to the confusion. For example, through trains from Trieste, Italy, to Villach, Germany (about one hundred miles) must now pass through Yugoslavia for a short distance, thus making an extra border stop necessary. In northern Yugoslavia, the rail routes converge on Budapest, the capital of Hungary, to which this territory formerly belonged, and it is extremely difficult to go between certain Yugoslav cities without entering Hungary.

These border difficulties give rise to all sorts of international agreements to facilitate transit. Often, customs and passport examinations are waived for through traffic. Several rivers, notably the Elbe, the Rhine, and the Danube, have been internationalized —thus traffic from France and Switzerland can pass down the Rhine to the Netherlands without interference from Germany. The free port also helps avoid border complications

Roads. Highway development has been very uneven in Europe with the greatest development in northwestern Europe and Italy. Except in a few regions, truck and bus transport have not seriously competed with the rail and water routes but have acted as feeders to them. High taxes and the high price of gasoline in Europe are likely to discourage any future development of motor traffic comparable with that in the United States. The private automobile is common only among the wealthier people. Among the middle and laboring classes the bicycle is the common substitute. Air services, heavily subsidized by the governments as a measure of military preparedness, have been well developed

The Atlantic Routes. The Atlantic is, by far, the world's major commercial ocean. West and south from the English Channel there extend in a fanlike pattern nearly a dozen ocean routes, over which are borne nearly half of the world's ocean trade. The outbound trade consists largely of European manufactures and a few raw materials such as coal and lumber. The Europe-bound trade, with the exception of manufactures from the northeastern ports of the United States, is largely bulky raw materials and foodstuffs.

By far the most important of these routes is that connecting the United States and Europe. It is curved, for the shortest distance between two points on a sphere is an arc of a great circle. This great circle route has special consequences in the North Atlantic, for it makes it possible for boats to go from Florida or Cuba to Europe and stop en route at Norfolk, New York, Boston, or Halifax without departing to any considerable degree from the shortest arc. So heavy is the traffic on this route that steamship companies have found it advantageous to follow certain special lanes. Thus, eastbound boats are always some miles away from the westbound lane, and fast boats often use a different lane from that used by low-powered steamers and sailing vessels This practice lessens the danger of collision in the fogs which are so prevalent on much of this busy route

Other important routes are those which are focused at the Panama Canal. The canal has made the establishment of round-the-world services profitable and has shortened greatly the water distance from Europe and eastern North America to the west coast of South America.

The Mediterranean-Asiatic Route. Second only to the North Atlantic route is the traffic on the route which passes through the Straits of Gibraltar, through the Mediterranean and through the Suez Canal to India, the East Indies, China, and Japan Important side routes branch off to Australia and East Africa Little of the traffic on this route goes the entire distance, but the destinations of the cargo are usually so arranged that through ships have little trouble in obtaining at least a moderate tonnage on all parts of the route. Thus, a ship may leave Japan with a cargo of textiles and other manufactured goods, discharge part of this cargo in the Philippines and replace it with copra or with rubber in the East Indies, and so on. On the return trip, European manufactured goods

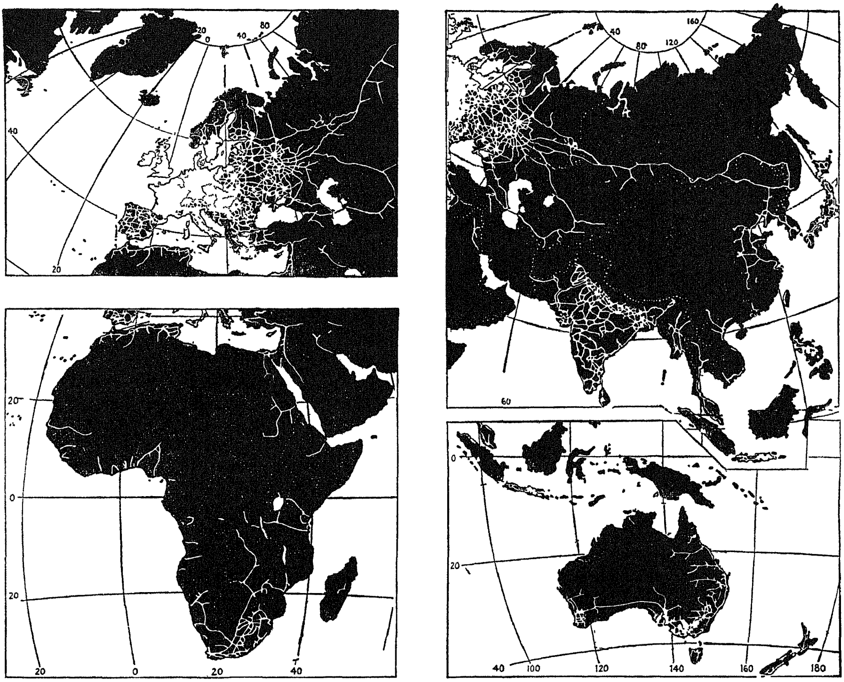


Figure 201. The white bands are 20-mile-wide strips along the railroads of 1925 A few additional lines have been built (notably in central Africa and Asia) but the general pattern is and is likely to remain the same. (Courtesy of Mark Jefferson, *Exercises in Human Geography;* see also Mark Jefferson's article, "The Civilizing Rails," in *Economic Geography,* July, 1928)

are carried which are replaced at various stops by Indian cotton, rice, rubber, and other raw materials for the factories of Japan. Singapore, Colombo, and Hong Kong are visited by almost every ship on this route because of the tremendous entrepôt trade at these ports A glance at their position on the world map should suffice to explain their importance.

Transpacific Routes. Most important of these routes is the great circle route from Seattle to Yokohama which curves so far north that it nearly touches Alaska. Many transpacific ships, however, go by the longer route from San Francisco via Honolulu to Yokohama. This is 5145 miles in length compared with 4285 miles by the first route, but the chances of picking up cargo and passengers at Honolulu are so good that the extra mileage is usually worth while.

Asia. The water routes just discussed carry most of Asia's trade, and the inland routes merely serve as feeders. Even as such, they usually become unimportant within a short distance of the coast. Only Japan and Java have really good railway nets. China has a few trunk lines on the river plains, and India has a considerable rail mileage connecting the principal cities, but most of the area of these countries is poorly served by rail or any other kind of transportation. The vast interior of Asia still depends on camel or yak caravans and human porters. The Trans-Siberian railroad from Moscow (Moskva) to Vladivostok crosses the continent, but it is primarily a military road and carries considerable freight only on its western half. It has been connected recently with Russian Turkistan by the "Turk-Sib" railroad

CHAPTER 34

THE GEOGRAPHY OF CITIES

IES do not grow up of themselves. Countrysides ;et them up to do tasks that must be performed ıtral places." [1] Modern metropolises, complex :y appear, are in their true nature merely -up crossroads. Their great retail establish- their financial and cultural institutions, and so e but counterparts of the store, the bank, the , and the church which are located at the cross- because there they are available to the greatest :r of people. The village is only a village be- its countryside is limited in size and riches. The :ryside" of the great city is nation-wide, or even wide, and the city is performing its tasks in a which is central to a large and rich region.

: primitive nature of the beginnings of the st American cities is evidence of their cross- position. New York, for example, was founded : Dutch as a trading post to tap the fur trade ich it was central. It marked a "crossroads" of routes, by Long Island Sound, and by the Hud- ıe Passaic, and the Raritan rivers, all of which ed on New York Bay Detroit, established by ench as a trading post, was central to both the and lower Great Lakes and marked an im- ıt center of land routes between the Indian ies of Ontario and Michigan. Chicago, St. Pittsburgh, Albany, and many other cities oc- sites which were "central" to their "country- in the days of the fur-trader's *bateau,* for the reasons they are important in these times of :d and steamship—they were and are at the ıg of routes largely determined by natural con- s.

k Jefferson, "The World's City Folks," in *Geographical* Vol XXI (1931), p 453.

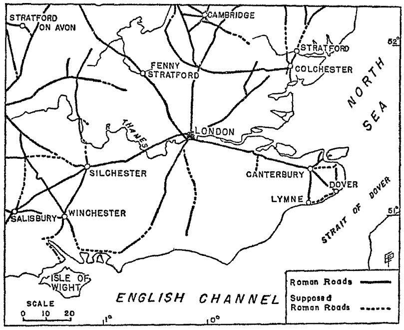


Figure 202. The Roman Roads of England and the position of London.

The Rise of London. The world's greatest metropolis, London, has grown from a fort and a collection of miserable huts which sprang into being because there the most important trails of southeastern England concentrated on the last place downstream where the Thames was shallow enough to be forded. Actually, London began as a Stratford (street-ford). There are eighteen of these "street-fords" in England which still bear the name Stratford The places where rivers were fordable were few enough that roads often concentrated on these "street-fords" and, because they were central to a wide countryside, markets and fairs were held there and churches were built. The Romans, when they invaded Britain, found the fords at London protected by stakes driven in the river and the "don" in the name London is supposed to be a corruption of the word "dun," meaning fort.

ANALYSIS OF PLATE XV: CITIES

A. Pittsburgh has outgrown the triangle of land at the n of the Allegheny (left) and the Monongahela and its manufacturing has spread up the river val- be near the life-giving transport by rail and barge, he uplands have been devoted to residential uses. A umber of bridges are necessary to bind together the f the district.

XV B. Note that the street pattern is regular on the flat plain along the lake shore, but this regularity is upset by the meanderings of the Cuyahoga River The crookedness of the river and the large number of bridges have made traffic by boat very slow. Civic interests are now planning to straighten the river. The street pattern may, however, remain irregular long after the original reason for it has been removed.

But not all of the Stratfords grew to be important. Their ultimate growth depended in large part on the importance of the routes which crossed at the ford. London became the most important because not only did the most important roads cross there, but it was advantageously located for trade with Europe and, later, with the whole world when boats became the carriers of a large part of the world's goods The first fordable place upstream on the Thames also marked the head of navigation on that river. In addition, London is not only "central" to the "countryside" of England and the Continent, it sits almost at the exact center of the land hemisphere of the world. So, whether the world's goods were carried by primitive trail, Roman road, or railroad; by coracle, galley, sailing ship, or steamer; it was the greatest British city because it was at the "central place" to the greatest "countryside."

The Functions of the City

In most countries, the village, the ancestor of the city,[1] exists to facilitate exchange. The surpluses of the neighboring producers and the demands of the neighboring consumers are brought together there. In Eurasia most villages and cities started as the sites of markets and fairs. In addition those individuals who had surpluses, not of goods but of skills, traveled from fair to fair marketing them because, there, they found large numbers of people in one place, an unusual condition in an agricultural or pastoral economy. The men who had a knack for pulling teeth, shoeing horses, repairing shoes, or singing a song found their way to the fair or market.

The functions of government also became concentrated at the fair or the permanent market town which grew up where it was held. Here it was most convenient to hold trials or collect taxes. The market town in England often became the county seat. The greatest market town of all became the seat of the national and imperial government When trade with other regions grew up, cities served as the collecting and shipping points for the surplus of the local region and the distributing points for goods brought from afar. But as long as there was little trade with distant areas, and each region was largely self-sufficient, there were few real cities

Cities Involve Trade. Great numbers of people cannot live in a small area, completely removed from the land which feeds and clothes them and consumes their products and services, without a highly organized, smoothly functioning system of transport and trade. This does not mean that every city is purely a commercial city or that its importance arises solely from its position on trade routes. It does mean, however, that without trade and transportation it could not grow into a city of any size. This can easily be seen in a city which serves as the center of a mining region. There would never have been any large mineral production had the region not produced something wanted by distant consumers and had it not been so situated that trade with its distant markets was possible. The mere presence of the resource does not build a city Without trade a city cannot specialize in mining or manufacturing or any other occupation. It would have to be content with the small population which the surrounding region could feed and clothe directly through its agriculture, collecting, hunting, and fishing.

Governmental Cities. Even administrative cities which are apparently independent of trade must satisfy the requirement of being "in central places." The position of Washington, D. C., which was created to be a seat of government, was selected because it was central to all the then inhabited parts of the new nation. In states like Pennsylvania, New York, and Illinois, where the capitals are distant from the real centers of population, much of the governmental business is carried on from offices in the metropolises, such as Philadelphia or Pittsburgh, New York City, and Chicago. In recent years, attempts to create capital cities in places remote from the avenues of trade and communication have met with poor success. This is especially true of the "new" capital cities of Canberra in Australia, Sucre in Bolivia, and the new "Federal District" in the remote interior of Brazil.

Resort Cities. It would seem at first thought that resort cities would be entirely dependent on the nature of the local site. However, the site conditions must not only be favorable, but the position must be such that the site is available to large numbers of people who desire the recreational facilities and who can afford to pay for them Thus, Atlantic City, New Jersey, is not merely a product of its miles of fine beach and its mild climate, it is the combination of these advantages with the large urban populations

[1] That there is no generally accepted definition of how large an agglomeration of population must be to constitute a city is indicated by the variety of definitions adopted by the censuses of various nations In the United States, 2500 or more people living close together make up a city for census purposes Jefferson (*op. cit*, p. 477) suggests that the figure of 100,000 be used, as there can be little doubt of the urban nature of such a large group

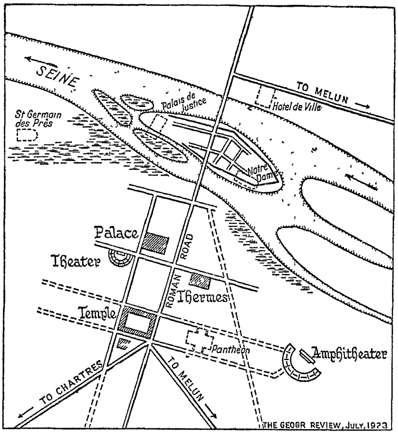


Figure 203 Plan of Paris under the Roman Empire The sites of a few modern streets and buildings are shown by broken lines. The site of Paris was selected because of the easy river crossing provided by the island Its growth is largely explained by its central position in relation to northern France, by its easy access to other areas over navigable streams, and by its political prestige (From Lucien Gallois, "The Origin and Growth of Paris" in the *Geographical Review* (July, 1923), published by the American Geographical Society)

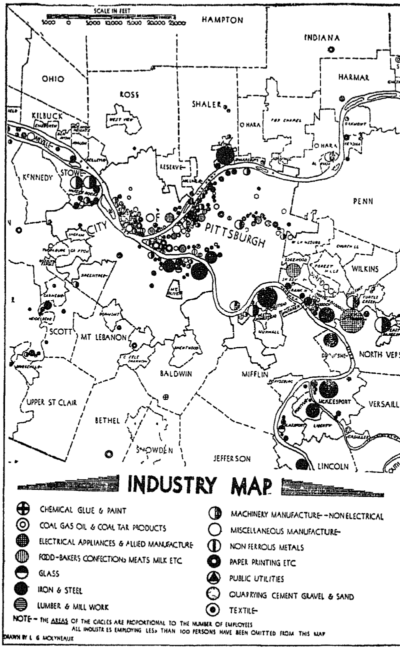


Fig. 204 This map of Pittsburgh and adjacent parts of Allegheny County shows clearly the influence of the rivers and the river valleys in locating industries. The emphasis is on the heavy industries because of cheap fuel but as in all well-developed industrial areas, there is also a variety of other industries (Courtesy of the Pittsburgh Commission for Industrial Expansion)

which live within easy reach and which have a high enough income to be able to afford the facilities offered. Brighton, in England, has similar position advantages in addition to its favorable site, and many other cities could be listed. Resort cities at a distance from population centers must be at least well served by transportation agencies and usually, because of their distance, attract only the wealthier clients. Miami and Palm Beach, Florida, are of this type. A great deal of the world's recreation business is in the smaller cities and towns or in truly rural conditions because of the desire of city people for a change from their workaday cosmopolitan surroundings. Many cities which have grown up because of trade or other advantages also attract travelers and people in search of recreation. The historic cities of Europe, such as London, Paris, Rome (Roma), Vienna (Wien), Venice (Venezia), and Athens (Athenai), owe much of their commercial and tourist activity today to their general atmosphere and historic associations. In North America, Boston, Philadelphia, New Orleans, and Quebec are of this type. The great metropolitan centers also attract the world's greatest artists and entertainers because there they may market their talents to the largest number of people. This, in turn, attracts thousands of people from the smaller cities and urban centers to enjoy these advantages, at least temporarily. The transient population which is attracted temporarily to London or New York makes up a large part of the clientele of the theaters, operas, and cafés.

Industrial Cities. Industries have always been associated with cities, but only within the last two centuries have cities been dependent on their factories rather than on their commercial and governmental activities. In industrial regions such cities now house the great majority of the population.

The nature of the industrial city varies greatly with

the dominant type of industry, but in general, they are less attractive in appearance than the more purely commercial cities Factories are built for efficiency rather than beauty, and their smoke and fumes frequently foul the air; nor is there anything attractive in the monotonous rows of cheaply built workers' houses.

The location of industrial cities will be considered more fully in the following chapters. Here it need only be pointed out that such cities grow out of commercial centers because cheap labor, available power, favorable marketing conditions, or some other advantage exists. Only in a few cases, such as Gary, have industrial cities been established to suit the needs of a particular industry; large enterprises alone can afford made-to-order centers.

Mining Cities. The exploitation of minerals on a large scale leads to the development of a characteristic combination of commercial and industrial city Rarely are such mining cities attractive. Huge piles of mine refuse, smoke and fumes from smelters and furnaces, and hastily erected buildings are typical The discovery of new mineral deposits leads to a mushroom growth; the exhaustion of old deposits leads to a rapid decline in population. Fluctuations in mineral prices may lead to similar booms and subsequent declines.

Residential Cities. The noise and congestion of industrial and commercial centers is usually so great that those who can usually reside in suburban areas. Groups of satellite cities frequently have been developed around large cities to serve as restricted residential areas. More space, better air, better schools, and a more pleasant social life are among their attractions. It is not improbable that, with speedier transportation, all residences will be placed outside the congested areas. In parts of New York and London this development has already begun, and as a result the financial district of New York and the "City" of London are almost uninhabited after business hours.

The Cumulative Nature of Urban Growth. Few if any cities belong exclusively to one of the types described above. Each urban function creates a demand for some other. For example, a commercial city attracts manufacturing, and a manufacturing or governmental city attracts commerce. New York City undoubtedly owes its early growth to its commerce and its advantages for commerce. That very commerce, however, attracted manufacturing. Thus New York became not only the greatest commercial city in the United States, but also the greatest manufacturing city.

The increase of a city's commerce and manufacturing requires more people to handle and finance it. The consequent growth of population necessitates the growth of community industries such as bakeries, laundries, tailor shops, etc., and increased retail and wholesale outlets. In this way does city growth tend to pyramid.

QUESTIONS FOR DISCUSSION

1. What physical factors helped to make London important? What historical developments were favorable?
2. In what general type of climate do most of the world's city folk live? Is this mere coincidence?
3. Analyze the nature of the leading cities in your state Why was each founded? What other functions does each now perform?

The Growth of Cities

Position Factors. Position is much more important than site in determining the growth of cities. Many fine urban sites are neglected, or occupied only by hamlets, because of poor positions. On the other hand, many cities with excellent positions have grown up in spite of considerable disadvantages of site. For example, the small area of level land available for city growth at Pittsburgh is a great handicap. New Orleans has had to solve tremendous problems of sewage disposal because much of its land is located below the level of the Mississippi River.

Among the most favorable positions for city growth are the following:

1. The head of ocean navigation on streams (Montreal, Bremen, Seville (Sevilla), Bordeaux, London, etc)
2. The mouths of streams, if there is also important coastwise trade (New York, Shanghai).
3. The junctions of streams important in inland water commerce or whose valleys are the avenues of land travel (Pittsburgh, St. Louis, Albany, Manaos)
4. The ends of great lakes important in inland water commerce (Chicago, Duluth, Buffalo).
5. The crossings of important land routes, especially railroads (Madrid, Milan (Milano), Indianapolis)
6. Locations near power sites if they are easily accessible to raw materials and markets (Niagara Falls, Minneapolis, Pittsburgh, Birmingham (England)).
7. Locations near bulky raw materials if power and markets are fairly accessible (Birmingham (England), Birmingham (Alabama), Magnitogorsk).

This list is not exhaustive and almost none of the cities mentioned owes its rise solely to the kind of position under which it is listed. Chicago, for instance, might be placed under 4 and 5. Minneapolis might be considered as influenced by 3, 5, and 6

Site Factors. Although position is more important, site factors cannot be neglected. When two sites have equally, or almost equally, good positions, the

better site can be more advantageously developed. When a poor site must be used because of its excellent position, there is a tendency to divert to some better site many of the normal functions of the city.

This dual-city system is especially important in the tropics Thus, because of its hot climate, La Guaira has a very small population although it is one of the leading Venezuelan ports. Many of the people concerned with its trade live in the capital city of Caracas, which has an altitude of 3000 feet and consequently a cooler climate Although Santos, Brazil, is the world's greatest coffee port, those of its workers who can afford to do so, live in São Paulo, on the plateau in a pleasanter climate, and commute to Santos daily. In Barranquilla and Cartagena, in Colombia, little but the *shipping* function of the country's commerce is performed. The centers of population, the offices, factories, and government activities are all in the cities of Bogotá and Medellín in the high plateaus of the interior where the climate is subtropical or temperate.

In locating certain special types of cities, site may be the predominant determinant For example, the fortified cities of the Middle Ages were often built around or upon some easily defended hill because the extra safety compensated for the inconvenient position. The location of resort cities is usually determined by some attractive site—of mining cities by the mineral deposit.

Site and the City Plan. Usually the greatest importance of site lies in its influence on the city plan. Topographical irregularities result in either crooked streets or hills which handicap traffic. A river flowing through the city congests traffic at bridge crossings. If the stream is navigable, its traffic may lead to the erection of factories and wharves along its banks; if it is only a shallow stream, it may be the center of a long narrow park.

The amount of level land in and around the city often determines whether the city plan will be cramped or replete with parks and wide streets. Level stretches are often given over to the railroads, through highways, factories, and office buildings, while the more rugged areas provide favored sites for the better residential sections.

QUESTIONS FOR DISCUSSION

1. How has the site influenced the plan of your city?
2. Does the growth of a large city hinder or help the dedevelopment of near-by smaller cities?
3. Did the displacement of canal transportation by railroads influence the development of cities? Why?

Some Urban Problems

Problems Due to Size. Urban problems become more acute as cities grow in size. The larger the city, the more complicated are its relationships to its hinterland, and the more frequent its interurban problems. For example, New York City's increasing water consumption has forced it to tap resources in the upper Delaware Valley which Philadelphia had planned to tap Sewage disposal is another serious problem. Chicago fights all the other lake cities and the Federal and Canadian governments for the right to take sufficient water from Lake Michigan to flush its sewage down the Illinois River.

Urban growth also causes problems within the city. Roads and street railways cannot handle the growing volume of traffic. Land values rise until people can no longer afford to live in city centers, and move to the cheaper suburban areas. Improvements needed to correct these problems cause an increase in taxes which injures local business.

Many city planners have asked whether the great cities are not too large to be economically or socially desirable and whether a dispersal of population into smaller units should not be encouraged. Indeed, for manufacturing, a smaller city may be more advantageous than a large one. There has recently been some tendency toward decentralization of manufacturing, especially in the United States. Commerce, however, still seems to require a central position, and there has been little success in attempts to decentralize it.

The "Geography" of the Skyscraper. To some degree the skyscraper, which is such a typical aspect of many city centers, owes its development to geographical conditions It has reached its culmination in New York City but is, in its simpler aspects, an old solution for the problem of many people on little land. The walled cities of the Middle Ages were, in a modest way, "skyscraper" towns. The circumference of their walls limited their growth and the only direction for expansion was upward. Considering the materials available, some of their buildings went to remarkable heights. Venice (Venezia), like New York, was an island town with very limited land and great commerce; its tall buildings were the consequence. New York has become the greatest skyscraper city because, in addition to the necessity for expanding upward due to limited area on its island, its growth was coincident with the development of fabricated steel, concrete, and the elevator.

Skyscrapers have developed recently in cities that

apparently have plenty of room in which to expand laterally. In such cases they are mere monuments to civic pride; sometimes, however, a position in the heart of the busiest trading district is so advantageous, and yet so limited, that the skyscraper really is justified.

History and Urban Development. Skyscrapers, elevated highways, and other devices in modern cities are necessary because of the inertia which encourages a city to develop far beyond the size desirable for maximum efficiency. Once a city is renowned for a specific business, it becomes extremely difficult to move that business to a less congested but less famous locality. Furthermore, the removal of a business involves considerable expense, including a possible loss of capital investment, and such moves are discouraged by the pressure of local businessmen—realtors, bankers, and merchants.

The makeshift appearance of so many sections of older cities is a consequence of the difficulty of displacing obsolete buildings, streets, and transportation facilities. These represent such a huge capital investment that only occasionally can private or governmental enterprise afford to replace them with completely modern structures. Thus each city is strewn with remnants of architecture which no longer serves the purpose for which it was designed.

Cities and Military Strategy. Many cities were originally located on sites chosen primarily for defense, for example the Hill Towns of Italy. The feature which was so advantageous for defense became later a hindrance to trade and new centers often developed on the outskirts of the old city to take advantage of the more accessible site. Thus developed a type of dual city which is commonplace in many parts of Europe.

Cities today must be defended at a distance. Long-range artillery and air raids have almost eradicated the advantages of sites on hilltops or within the bends of rivers. The advantages of mountain barriers, lakes, rivers, and swamps still remain but it is preferable that these natural defenses should be some miles away from the city.

The modern city may well be considered as the nerve center of its hinterland. Air raids upon such cities are justified by military experts on the ground that they upset the normal economic life of both the city and its hinterland and thus impede the flow of supplies to the front lines. It appears that the concentration of economic life in large cities adds to the vulnerability of a country. Hence military as well as economic considerations may encourage further decentralization of many urban functions.

The Local Geography of Cities. The actual pattern of each city is determined by the nature of its site and by its past historical development. There are, however, certain general conditions which prevail in most cities. Usually the ancient nucleus from which the city grew will be the center of its commercial and financial activities and will have the most valuable and centrally located land. Here will be the head offices, the banks, great department stores, government buildings, and places of amusement. These are the high-income producers in proportion to the space they occupy, and these can afford to use the most valuable land. Here will be the skyscraper zone.

A zone of hotels and apartment houses is usually found close to the financial center because these, also, are high-yield users of land. They house the transient population which is attracted to the business center and which can afford to pay the high cost of living in the center of things.

Heavy manufacturing, because it uses more land, is likely to be somewhat removed from the city center. It will also be located with respect to the railroads and to the water front if the city is a port. Lighter manufacturing which can use loft buildings may be located close to the financial and commercial district. Relatively close to the heavy manufacturing will be the homes of the less skilled workers, for these, because of their low incomes, cannot afford to spend much of their earnings for transportation.

The better residential districts are usually relatively remote from both the heavy manufacturing and the commercial districts The objective sought is land cheap enough so that a person of moderate means can own space for a lawn and perhaps a garden

The provision of parks and playgrounds to serve the uses of health, exercise, and recreation is often one of the city's most complex problems, especially if it be an old city which has had an unplanned growth. Fortunate, indeed, is that city which has an abundance of park land within easy reach of all of its population.

For each residential district there must also be a local shopping district, for the housewife—or her servants—must be within walking distance of grocery and drug stores, bakeries, and butcher shops. Thus, a land-use map of a city usually shows it to be made up of a commercial core and, perhaps, a manufacturing core, around which are clustered "neighborhoods," each complete with its own shopping district and service facilities Close to the center of the city these neighborhoods crowd together in close succession;

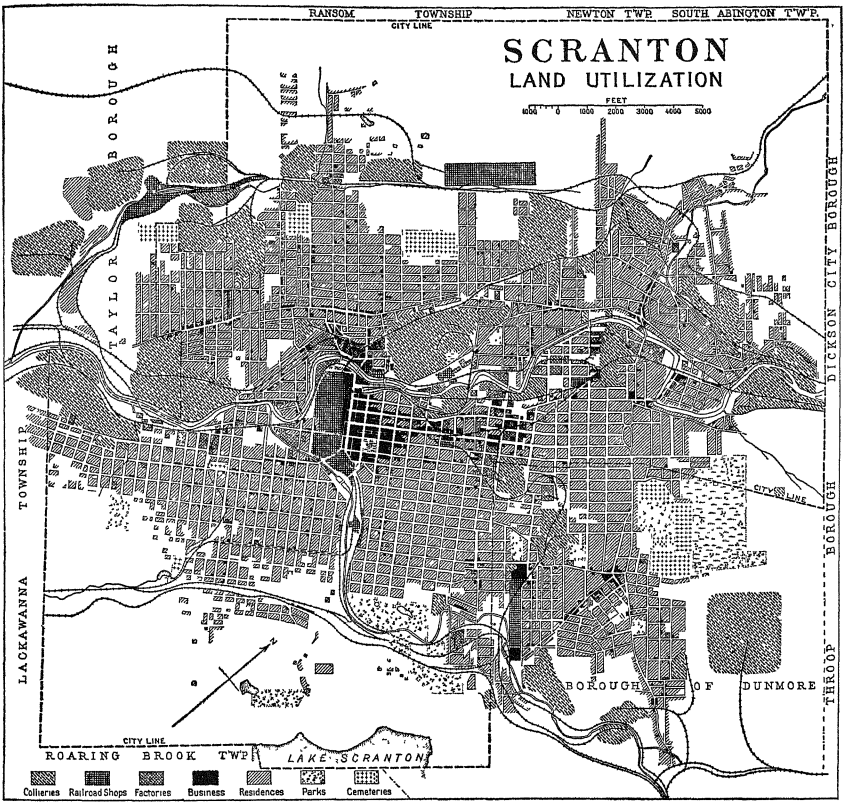


Figure 205. Land utilization in a leading anthracite coal city. (From Clifford M. Zierer, "Scranton as an Urban Community," *Geographical Review*, July, 1927)

farther away they spread out more until the suburbs and, finally, the open countryside is reached. These neighborhoods are bound to each other and to the commercial and manufacturing cores by the local transportation system which is both cause and effect of the trend of land use, and may, itself, be an adjustment to local topography and a host of other conditions.

The Metropolitan District. The preceding discussion has demonstrated that a great city actually includes more than the land within its political limits. The business carried on within the city is the factor which has attracted the people to its suburbs and has caused industry to be established in the surrounding area, outside the political city, but within the reach of all of the advantages which have been responsible for the city's growth. Thus, the "greater city" of New York includes all of the northern New Jersey cities and towns which crowd the arms of the tributaries of New York Bay and even reaches far into Westchester County, New York, and into parts of southwestern Connecticut. Such a "greater city" is a "metropolis"

and the "metropolitan district" is the real geographical city. In the census statistics of the urbanized modern nations, it has been necessary to arrive at a definition of a "metropolitan district." The United States Census has defined it as being, "in addition to the central city or cities, all adjacent and contiguous civil divisions having a density of not less than 150 inhabitants per square mile." [1] Such a definition, experience has shown, will bring into the metropolitan district all of the area surrounding the central city which has truly urban conditions. It will not, however, include all people who work in the central city nor, necessarily, all of the surrounding towns whose economies are merely parts of the metropolitan whole. It should be pointed out in this connection that the real significance of a city lies in the number of people who work in it, not merely the number of people who sleep there. In 1921, the commercial heart of London (called by Londoners, "the City") had a daytime population of 416,150 and a nighttime population of only 13,709.

Industrial Area. The United States Census has also found it convenient and informative to group certain political units into combined "industrial areas" in order to evaluate their relative importance and to allow the presentation of industrial statistics for the *geographical,* rather than the *political,* unit. It has defined an "industrial area" as follows:

> This term signifies an area having as its nucleus an important manufacturing city and comprising the county in which the city is located, together with any adjoining county or counties in which there is a great concentration of manufacturing industry The number of wage earners employed in each area is at least 40,000.[2]

Regional Planning. All of these statistical units have been created to arrive at some accurate picture of the real *geographical city.* Of even greater significance are the "regions" set up by the regional planning federations or commissions of the great urban centers. They are designed to unite all of the area influencing and influenced by the central city core and to allow for the planning of the future development of these "regions" by cooperative effort of the various political subdivisions. In all cases, they include within the "region" a large area of open country. It is hoped that the development of this open country can be planned and controlled to avoid the mistakes of the past. It is also hoped that some of it may be developed to serve as "open spaces" for rest and recreation for the crowded population of the urban center itself.

City Planning. The need for planning is greatest within cities, for there problems of obsolescence, congestion, and poor arrangement are most serious. Today over 1300 American cities have zoning ordinances and over 1500, building codes to regulate the worst of these evils. Nevertheless, most American cities have far to go in the direction of rational city planning.

Because of the thorough way in which they have attacked the planning problem many European cities might well serve as object lessons to American cities. Old buildings have been removed to make room for parks and boulevards, building laws have been enacted to regulate the use, quality, and architectural style of buildings in each part of the city. The resulting city is improved both in appearance and convenience.

American city-planners recognize the desirability of building restrictions of the type just mentioned, but often the inauguration of such measures is prevented by limitations in the city charters or by lack of supporting public opinion.

> The growth and welfare of many individual cities shortly will be affected by Nation-wide population trends, by changes in methods of production, transportation and distribution, and even by national policies with reference to interstate commerce, tariffs, and international relations. Urban land policies, therefore, are not merely questions of local public opinion and legislation, but they are intimately related to State and National constitutions and laws and to other factors even more difficult to control Cities will probably, unless present trends are reversed by large-scale rehabilitation of the blighted areas, continue to increase in density of population at the periphery and to decrease at the center Land values most likely will follow the same course. But on the whole, the slowing down of growth due to an approaching stationary population has created opportunities for effective social control over land use and community development seldom equaled in American history [3]

QUESTIONS FOR DISCUSSION

1. Why has Chicago become a great railroad center?
2. Why is decentralization of manufacturing relatively easy and decentralization of commerce difficult?
3. Why do cities tend to survive even after the reason for their origin has disappeared?
4. What provisions for zoning exist in your city? Do you think that these laws should be made stricter? Is there any re-zoning which seems to you desirable? Why?

[1] Fifteenth Census of the United States, *Metropolitan Districts,* p 5. Government Printing Office, Washington, 1932

[2] Fifteenth Census of the United States, *Manufactures 1929,* Vol 1, p 11. Government Printing Office, Washington, 1933.

[3] *Our Cities, Their Role in the National Economy* (Report of the Urbanism Committee to the National Resources Committee) Government Printing Office, Washington, 1937, p. 47.

CHAPTER 35

THE NATURE AND DISTRIBUTION OF MANUFACTURING

MANUFACTURING is the processing or combining of materials to make some desired product. Many people in the modern industrial nations think of manufacturing as something that is carried on only in complex, organized factories. Actually, there was manufacturing before there were any factories and a tremendous amount of manufacturing is carried on today, even in highly industrialized nations, entirely apart from the factory.

Wherever there are people there will be some manufacturing. There are universal demands for food, clothing, shelter, tools, and means of transportation. Primitive people, whether they lived in ancient times or inhabited some isolated region of the world just yesterday, combined or processed materials to meet these needs. Today, even the ultra-modern young lady who lives upstairs over a delicatessen will be forced to engage in one of the most ancient of the home's manufacturing operations. She must at least open cans and apply heat to their contents in order to make the foodstuffs palatable, and that is as truly manufacturing as the heat treatment of steel.

The Origin and Growth of Manufacturing Regions

The Industrial Revolution. A glance at the map of occupations, Fig 9, will show that western Europe, especially about the English Channel, is one of the large regions of the world labeled "Industrial." It was here that the shift of many types of manufacturing from the home to the factory took place, and here power and machinery on the modern scale were first applied to the doing of man's work. This series of changes is spoken of as the "Industrial Revolution."

During the Middle Ages and before the people of this region, like those of the rest of the world, were mainly engaged in agriculture. Each family or village was sufficient unto itself. There was a great deal of manufacturing in the home to meet local needs, but there was little trade and, consequently, little specialization in manufacturing. Toward the end of the Middle Ages, the Crusades and the early explorations opened up new trade routes and acquainted people with a wider variety of goods. Markets and fairs were held in central places and people began to exchange the products of their individual skills or their regions for the products of others This led to even further explorations by traders in search of new markets and materials, and a rapid increase in commerce resulted. Active commerce made the division of labor, both by task and by region, possible and profitable.

The Division of Labor. Very early in human development it was learned that work is done more efficiently if each member of the economic unit is assigned one set of tasks to master through constant repetition. Without trade, division of labor could occur only along broad lines, such as household tasks for women and field work, the hunt, and war for men. With an ever-widening market due to increased trade, the man with specialized skill or training could devote all his time to his calling and exchange his skill or products for the necessities of life. Adam Smith, the English economist, pointed out that the larger the market, the greater the division of labor possible. It was western Europe that had become most active in trade, therefore it was western Europe which could encourage skill and market its products over the widest area. England, influenced by its insular position, became the leading sea-faring nation, led in exploration, trade, and colonization and, by the middle of the eighteenth century, had become the leading manufacturing nation.

The Factory System. The increasing size of the market and the resulting division of labor led almost inevitably to the establishment of factories. The traders secured the raw material and marketed the finished products and it was natural that they should try to control its manufacture. By getting a number of workmen under one roof it was possible to subdivide the tasks more efficiently and control the process so as to meet the demands of specific markets When new machines or processes were invented or power came to be applied to the performance of some operations,

the factory owners were quick to see the advantages and had the capital necessary, thus further increasing the relative importance of factory as compared with home industry.

Inventions and Power. For very good reasons the significant early industrial inventions took place in the textile industry. The demand for cloth and clothing is universal; the labor of cleaning, combing, and spinning the fiber occupied a disproportionate amount of the time of the household; and the weaving of cloth and the making of garments required considerable skill. As soon as active trade made a supply of cloth available, it became cheaper for most families to give up home manufacture. Thus the market for textiles made in the new "factories" grew rapidly and the demand for means of increasing production was greatest in that line.

England with her active trade felt this need keenly and the significant inventions were made in that country In 1738 Kay invented the flying shuttle which speeded up weaving and created a demand for faster spinning to keep the weavers supplied with yarn. Hargreaves' spinning jenny in 1764 was followed by Arkwright's water frame about 1769 and Crompton's "mule" in 1779 These textile machines called for the application of power and were first run by water, but the invention of the steam engine by Watt (1769) forecast the modern industrialism based on coal power.

Growing industrialization gave rise to new problems in the application of power, sources of fuel, metals to make machinery, and a host of other needs. These were met where they arose, and western Europe, especially England, by 1800 was far ahead of the rest of the world.

Regional Division of Labor. By 1800 increase in trade made it possible for some regions to specialize in the activities for which they had some special advantage by virtue of skill or physical resource. England could sell cotton and wool cloth, iron goods, pottery, and other products of her factories in exchange for the raw materials and foodstuffs of other nations. For the first time in the history of the world there was such a thing as a "manufacturing" or "industrial" region.

QUESTIONS FOR DISCUSSION

1. Some writers think that the growth of world commerce in the seventeenth and eighteenth centuries was more important in world history than the Industrial Revolution. What is your opinion? Support it.
2. Under what circumstances might household spinning and weaving of cloth exist today?
3. What was there in England's environment that gave her leadership in the expansion of commerce?

The Spread of Industrialization

The commerce and colonization which spread the desire to consume the products of the modernized manufacturing also spread the knowledge of its techniques. Colonists with European standards of consumption settled North and South America and Australia The mother countries hoped they would serve as a market for manufactured goods and devote their attention to producing raw materials and foodstuff for exchange. In many instances, however, transportation was so difficult at first or the price of imported goods was so high that some of the new colonies turned to manufacturing for their own market Often raw material or fuel supplies were more plentiful in the new countries than in the old, and growing markets were at hand

Eastern North America. The largest area to be actually colonized by Europeans was in the Americas. A further analysis of the map of occupations, Fig. 9, will reveal that northeastern United States and southeastern Canada constitute the world's other great industrial region. Here a young and vigorous people with European standards of consumption and production found a tremendous variety and quality of raw materials and power and a growing market. They not only adopted the techniques of the contemporary Industrial Revolution, but developed new ones which eventually put them far ahead of the Old World in many lines of endeavor.

The direction of the development of an industrial system in a new region is determined by the particular circumstances of that region. In the United States and Canada there were few people in relation to vast resources, distances, and areas. As a result, manufacturing was guided toward the development of labor-saving machinery—of the agricultural, business, housekeeping, and material-handling types—and mechanical means of transport—such as railroad equipment, automobiles and trucks, and airplanes. The size and richness of the home market has encouraged the development of techniques of large-scale, highly mechanized manufacture such as standardization of parts and their assembly in large quantities on moving assembly lines.

Continental Europe. Due largely to political considerations and the fact that ocean commerce was largely controlled by England, many of the present industrial regions of continental Europe developed later than those in England and even after manufacturing in the United States was well established. Belgium and France, it is true, developed industrially from a quite early date, but until the 1860's Germany,

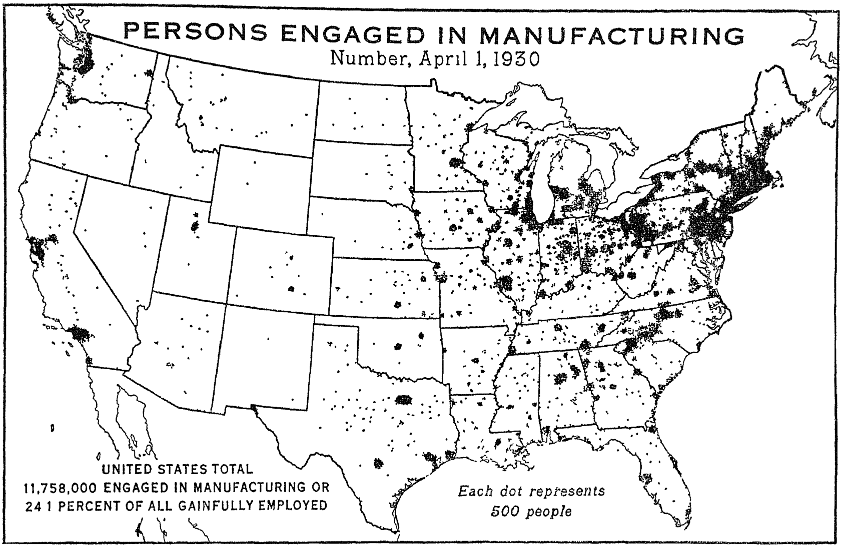


Figure 206 Although there are definite areas of industrial concentration, some manufacturing is carried on wherever there is any considerable population. (Courtesy of U. S D A)

Italy, and Austria were but loose collections of small, semi-independent principalities. Under such conditions there were many political handicaps to trade and manufacturing and only after the rise of national states in these regions was there much industrial progress.

As in North America, industrialization was conditioned by the nature and number of the people in, and the position and resources of, each country. Belgium had an industrious people, a central seaboard position at the mouth of rivers allowing access to the interior, and excellent coal resources. Textiles, iron and steel products, glass, cement, and chemicals have been her specialties. France has few raw materials (except iron ore and bauxite) and no large supplies of well-located coal of good quality. Her manufacturing specialties have been art goods, textiles, and fine clothes. Germany, with abundant but predominantly low-grade coal, a poverty of other raw materials, but a disciplined and highly competent people, has gone far in all branches of the chemical industries and the manufacture of machinery, munitions, and textiles. Sweden, Bohemia, northern Italy, and northern Spain are peripheral areas with considerable industrialization.

Japan and Russia. The only nation in Asia sufficiently industrialized to be important in the export market is Japan. This country experienced an economic awakening after 1870, and since 1900 has become rapidly industrialized. It has poor raw materials and little fuel, but a large cheap labor supply and an island position close to the densely populated Asiatic mainland. Textiles, paper, toys, and novelties which can be made cheaply out of imported raw materials and canned sea-foods from near-by waters are the principal manufactured exports.

After the Bolshevik Revolution of 1917-18, Russia, too, went through an economic reorientation. A balanced national economic life in a hostile (at least economically) world became the ideal, and the nation planned and quickly carried through an industrialization such as the world has never previously seen. With her own vast potential markets still not satisfactorily supplied, Russia is not yet a serious exporter of manufactured goods. Like the United States, it has a large local market, vast resources and distances, and its

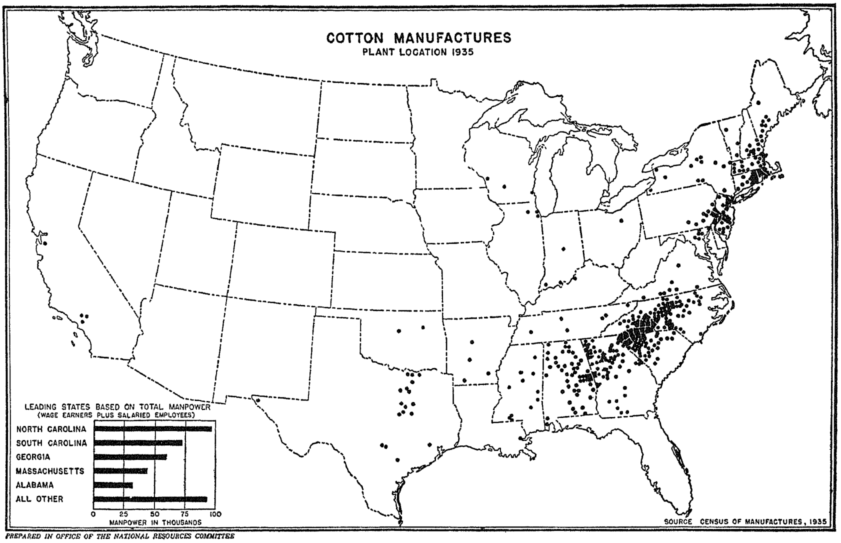


Figure 207. The manufacture of cotton textiles is so simple that the industry is found in almost every country Cheap labor and power account for the concentration in the South which the map shows. (Courtesy of the National Resources Committee)

domestic manufacture has been organized to emphasize agricultural machinery, transport equipment, and the wide variety of goods needed for consumption by the average man.

Economic Nationalism. The relatively free flow of trade which led to specialization in manufacturing in some of the older industrial countries must continue if they are to maintain their supremacy. But, especially since the World War of 1914-18, new states have sprung up, old trade patterns have changed, and many artificial trade barriers in the form of tariffs, embargoes, and bounties have come into effect. Many countries now plan for as large a degree of economic self-sufficiency as possible. Thus an artificial encouragement of manufacturing has caused industry to be much more widely dispersed than formerly.

Types of Industries Which Have Become Widespread

A still further analysis of the map of occupations will reveal small isolated industrial regions widely scattered throughout the world. The industries in these regions are distinctly limited in number and characteristics. Most of them are either industries whose products have a world-wide demand or simple manufactures which process local raw materials which are too bulky or perishable to be shipped in their original state.

Perhaps the outstanding example of manufactures which have spread widely is the cotton textile industry. Factories for the production of cotton cloth have sprung up in large numbers in Japan, China, India, Australia, South Africa, in several South American countries, and in Mexico. In this industry the processes are relatively simple, very little skilled labor is needed, and machines are nearly automatic. The universality of the demand led many districts which formerly imported cloth in large quantities to purchase machines from the older manufacturing countries and make cloth for themselves with the cheap labor and cheap power which are fairly widely available. Thus, of all of the modern factory industries, the textile industry is probably dispersed most widely.

Other industries which supply a universal demand, have simple processes or automatic machinery, or can use cheap labor to advantage have also become widespread. Among them are the manufacture of shoes, the milling of flour, brewing and distilling, and the manufacture of power and illuminants. Almost any Latin American nation, or any large city of China, has many or all of these industries.

Industries Continuing in the Old Centers. The difficulty experienced in attempts to establish certain industries in the newer industrial regions would seem to indicate that there are types of manufactures which will probably continue to be concentrated in the traditional centers. Among them are the industries producing capital goods: that is, structural steel, machinery, tools, vehicles, ships, electrical appliances, chemicals, business machinery, and many others Although these may be consumed to some extent in many parts of the world, the bulk of the market is in the older industrial countries In addition, their manufacture involves complex techniques, a high degree of skill, and experienced management, all of which are associated with industrial maturity

Perhaps the most interesting examples of apparent departures from this rule are Japan and Russia. Both nations have adopted industrialization within relatively recent years, and both have made rapid strides However, neither has made, as yet, any contributions to compare with the stream of new inventions, processes, and materials which are constantly being added by research to the store of knowledge in the older industrial countries. Both are still operating largely with imported ideas and imported machinery.

QUESTIONS FOR DISCUSSION

1. Why are most of the world's typewriters produced in the United States?
2. Is the growing self-sufficiency in some nations likely to raise or lower their standard of living in the long run? Why?
3. What are some of the advantages likely to be possessed by a nation with a long tradition of industrialization?

The Location of Manufacturing Plants

The preceding discussion has been devoted to an analysis of the industrial system and to an explanation of the distribution of industrial concentrations. The remainder of this chapter will analyze the factors influencing the location of manufacturing plants within industrialized nations. Such an analysis is by no means easy to make because the factors influencing plant location are, usually, not simple. In addition, the problem is further complicated by the influence of numerous non-physical factors which change rapidly.

The Position Factors. It is customary to group plant-locating influences somewhat as follows: (1) accessibility to markets, (2) accessibility to labor supply, (3) accessibility to raw materials, (4) accessibility to power and fuel. These influences usually determine the area within the industrialized nation which will have the lowest major costs and will, therefore, be most favorable. These may be described as the *position factors.*

It will be noted that no direct mention of transportation is made in the above list. Transportation is important, but it can hardly be separated from the influence of any of the position factors. It is included in the concept of "accessibility" in all of the influences indicated above. The manufacturer is not particularly interested in the distance which his raw material, for example, travels, but he is vitally interested in the cost of that material at the door of his factory, and that cost involves transportation

The Site Factors. When the manufacturer has decided, on the basis of the position factors, what part of the country would be preferable for his plant, he looks about for a definite site on which to locate. This brings into play a host of site factors which determine the exact location within the major favorable area. Some of these numerous and complex factors are physical and some are definitely social or political. The following list is designed merely to show the sort of influences involved and cannot be complete:

1. Governmental costs—such as taxes, factory regulations, and labor legislation
2. Physical costs—such as costs of water supply, cost of land and buildings, and availability of daylight
3. Financial costs—such as availability of capital and interest rates

The way in which these position and site factors operate to determine plant location was illustrated by the founding of Gary (pages 3-4).

Result of Trial and Error. In actual practice, few industrial plants have been located definitely by a scientific analysis of all of the factors influencing them —as with the steel company's plant at Gary—and their distribution comes about largely through trial and error. Most of the successful plants are successful because their location is favorable, in most respects, and many of the unsuccessful ones are dark and deserted because experience showed, *after they were in operation,* that the location was for some reason unfavorable. However, management also enters and may partly explain apparent exceptions. Highly efficient

management may be able to keep a plant running profitably in spite of a relatively poor location, while poor management may wreck an ideally located plant. In the long run, however, there will be a tendency for the well-managed concern to move to a better location when it becomes necessary to replace worn-out structures; and the plant which is favorably located but fails, due to poor management, is likely to be taken over by better management because of its favorable location.

In addition, the factors affecting plant location may change rapidly because of improvements in transportation and changes in consumer demand or in processes. Then locations which were formerly favorable may become relatively unfavorable, but cannot be immediately deserted because of the large investment in capital and the large local supply of labor. Management and labor are encouraged to strive toward higher efficiency and to accept lower returns in an attempt to retain the traditional industry. This tendency to remain in the same location is usually spoken of as *industrial inertia*. But it, too, usually yields in the long run to the pull of more favorable locations elsewhere. The process takes time, however. High-cost plants may continue to operate until some major catastrophe—such as fire, depression, or labor trouble—give them the *coup de grâce*.

The Resultant of Forces. An industry is seldom located by any one factor but by the influences of a combination of factors. Seldom do all of these forces pull in the same direction and the actual location of a plant may not be *physically* near any of the common locating factors except labor. The steel plants along the Great Lakes, for example, are not physically close to coal or iron ore, but the location of both affect the location of the industry. Steel plants are situated where the total costs are lowest—that is, where iron ore, coal, and limestone may be brought together most cheaply at a place having labor supply and access to market.

The problem of plant location is like a problem in the resultant of forces. The position of the earth in the solar system at any time is due to a neat balance between the forces exerted by the sun and the other planets. The earth isn't very near any of these bodies, but its position is determined in part by all of them. In addition, the nature and weight of the earth itself affects its position in the system. In the same way, the nature and requirements of a given type of manufacturing determine the factors affecting it and the strengths of their influences.

Some Influences of the Market Factor. The industries which feel the pull of markets strongest are: (1) those which have a perishable finished product, (2) those which prepare goods according to the customer's specifications, (3) those in which style is involved.

Perishable Finished Products. The market influence is usually obvious in determining the location of industries making perishable products. Among them are ice factories, ice-cream factories, bakeries, and, in fact, most industries preparing food for final consumption. However, cheap and speedy transportation has resulted in some concentration of industries which were formerly carried on in every neighborhood. For example, ice-cream and bakery-products manufactures tend to be concentrated in distributing centers for populous districts and to be distributed to a wide market by fast trucks. The location of the meat-packing industry was formerly more clearly determined by its market than at present. Refrigerator cars have allowed concentration in a few centers, although the limits of its market may be thousands of miles away.

Customer's Specifications. While industries making largely standard goods or interchangeable parts may be subject to growing concentration in a few centers, any industry whose product must fit, not the average person, or the average house, but some particular one, must be carried on where the customer is. Thus, dressmaking, custom tailoring, interior decorating, and other such industries find the pull of the market strongest. Service and repair industries also must be carried on in the market, for requirements vary with each customer. These are the "purest" of the local community industries.

Style Factor. Styles originate chiefly in huge metropolises where division of labor is carried to its highest degree. As a result, a few world centers such as Paris, Vienna, London, and New York originate most of the styles and, in or near them, art goods and stylish clothing are manufactured in large amounts. Location in the heart of the market allows designers and manufacturers to keep their fingers on the style pulse of that portion of the public to which style is most important.

Labor Supply. The location of a few industries is largely determined by labor supply. Many, such as the clothing industry, emphasize the importance of a cheap labor supply, but even here, labor is largely a secondary factor. Any but the cheapest clothing must be manufactured close to the market because of the

style factor involved. Within areas easily accessible to market, those districts having cheap labor are preferred to those that do not, but cheap labor alone cannot induce clothing plants to stray far from their market.

The manufacture of jewelry would appear to be one that was absolutely dependent on the skill of its labor supply, but the force of the market factor can be seen when it is realized that a great deal of jewelry is custom made and that there is a large style factor involved. Again, one unit of an industry may set up in a town long famous as a center of that industry, ostensibly because of the trained labor force available; but all the other forces are favorable—as evidenced by the prevalence of the industry there—and labor supply is but one of the advantages.

Parasite Industries. Much is made of the influence of labor as a locating factor in "parasite industries." Excellent examples are the factories making cheap clothing in the coal-mining or cement districts of Pennsylvania. The women and girls of the miner's or cement worker's family find no outlet for their labor in connection with the main industries and are available as a labor supply for the clothing industry, where little skill is required. In this region, then, the clothing industry is said to be a "parasite" on the coal or cement industry. Even here, however, the parasite industry is not located far from its principal market.

In general, labor is the most mobile of location factors. If larger markets spring up in new areas, skilled labor may be brought in, or local labor trained to perform the new tasks

Raw Materials as a Locating Factor. Two main types of manufacturing are strongly influenced by the location of their raw materials: those in which the raw materials are perishable and those in which the raw materials are bulky and expensive to transport.

Canning, grinding of sugar cane or beet, and the manufacture of butter and cheese are simple examples of the first class. It will be noticed that the finished product of each of these industries is relatively imperishable and can stand transportation.

The second class is represented by such industries as sawmilling, the concentration of ores (and their smelting if power or fuel is available), the manufacture of wood pulp, and cement making, all of which have such bulky raw materials that it is not profitable to ship them any considerable distance.

Another type of manufacturing which tends to settle close to its raw-materials supply is that using bulky by-products of another industry—like cement making which uses blast-furnace slag of the iron and steel industry as its raw material.

Fuel and Power. A few industries requiring large quantities of them are strongly attracted to sources of power or fuel. The refining of bauxite has already been mentioned. Another example is the glass industry, whose raw material is widely available. It has followed cheap fuel from the coal fields of Pennsylvania and the natural-gas fields of West Virginia and Pennsylvania westward with the rise of new gas-producing fields. The "artificial" fixation of nitrogen also requires large amounts of cheap power and, largely for this reason, has become important where hydroelectric power is available—as in Norway, and at Muscle Shoals on the Tennessee River—or near the coal fields—as in Germany and England.

Nearly every industry needs power in greater or lesser quantities, but in many it is a small element in the total cost. Certain industries—such as blast furnaces and smelters—find cheap fuel absolutely necessary, but the ores to be smelted are also absolutely essential and the ultimate location is one where both are available. Districts having ore and little coal—such as Brazil or Mexico—either do not exploit their ore or else ship it, often after concentration, to regions having coal. In the latter case, either cheap water transport must be available or the ore must be of high value in proportion to its bulk—as with tin ore from the Far East, which is smelted largely in Wales An interesting effect of the absence of abundant power is the tendency to manufacture articles requiring little of this resource. The predominance of machine-shop industries in New England is an example of this influence.

Site Factors. Many districts of the United States recently have been advertising their advantages as locations for industries. Among the assets often stressed are low taxes, cheap land—or buildings already available—"contented" and low-price labor, lack of stringent factory legislation, capital available, and many others. The strength of these attractions varies considerably from industry to industry, but it seldom does more than determine which of several possible sites within a region of otherwise favorable costs will be selected. These attractions appeal most to the thousands of smaller concerns whose processes are such that they may be carried on with unskilled labor almost anywhere where there is average rail transport Firms manufacturing toys and novelties and some kinds of clothing and printing concerns are mobile because they can use rented loft space and small amounts of power, and because both their raw mate-

rials and finished products do not cost much to ship. In the United States such businesses can be carried on almost anywhere east of the Mississippi River and north of the Ohio and Potomac. As a result, a town with low site costs may attract a variety of such concerns.

The social, economic, and political advantages of one site over another may not be permanent. A district selected because it has cheap nonunion labor may eventually become organized, taxes may be raised, land values may increase due to increased population, new administrations may enact factory legislation which removes former low costs. In such circumstances firms which can operate almost anywhere may move on. The more firmly rooted plants with large capital investments often find it impossible to move. Those which are really favorably located or are well managed can usually survive in spite of considerable increases in site costs.

Railroad rates also affect plant location. In the United States, for instance, rates are controlled by the Interstate Commerce Commission. In theory an attempt is made to make rates reflect such geographic factors as the length of haul and cost, but many changes have been made which are based on nonphysical factors. Rates from interior points to the Eastern seaboard, for example, are based on a series of artificial differentials which appear to favor ports south of New York. In Southern territory in the past rates have been based on terminus-to-terminus haul, a fact which has led to concentration of activity in the larger terminal cities.

The Localization of Industry. When many units of the same industry cluster in one city, the industry is said to be *localized* there. Several examples come to mind immediately Akron, Ohio, is noted for its tires and tubes; Pittsburgh for its steel; Troy, New York, for its shirts and collars; and Brockton, Massachusetts, for its boots and shoes. The success of the first plant demonstrated that the location was a good one. Then other similar plants located there, not only because the location was favorable, but also because of certain advantages which arise from having several plants of the same kind located closely together. Some of these advantages may be summarized as follows:

1. A trained labor supply is assured.
2. Capital is often easy to obtain because local bankers have become convinced of the success of the industry.
3. Service industries—such as machine repair, machine construction, etc.—become available
4. Industries using the by-products of the principal industry spring up
5. Shipping facilities peculiar to the industry are often supplied by the transportation agencies
6. Municipal, or other, ordinances favorable to the industry are often enacted
7. Division of labor by process may be carried to a much finer degree because of the large number of units being manufactured.

Transportation and Power as Decentralizing Forces. It has been pointed out previously that fast, cheap transportation has allowed many community industries, which were formerly carried on wherever there were people, to be concentrated in a few centers and distribute their products over a wide area. There is also some tendency for cheap transport to have the opposite effect· cheap transportation of raw materials allows an industry to become increasingly independent of resources and allows other factors, such as market or labor, to become more important.

The growing use of purchased electrical power by manufacturers has also tended to decentralize industry. Increased efficiency in producing electric power—by improvements in the steam boiler, the development of low-cost hydroelectric plants, and by interconnection of generating plants—and increased efficiency of transmission have made cheap power available over wide areas. This has meant that only those industries which require tremendous quantities of the cheapest power are any longer anchored to power sites or coal fields. Again, cheap power has strengthened the pull of the market.

Selling costs in several industries in the United States have tended to break down large concentrations and encourage manufacture in widely scattered plants close to market. It was found that selling costs were a very considerable part of the total delivered price. If proximity to market allows the producer to meet shifting market demands more quickly and cuts down costs, the medium-sized unit, located in a regional distributing center, has a distinct advantage. In some industries at least large-scale, centralized units appear to have become too large to be efficient, especially through periods of curtailed production.

QUESTIONS FOR DISCUSSION

1. Consider the location of any factory with which you are familiar Why was it so located? Are the advantages of its site as great today as in the past?
2. Are the site or position factors most likely to change in an industrial region?
3. Why do markets and labor rank near the top as locating factors in the machinery group of industries? Why does power rank low?

CHAPTER 36

SOME AMERICAN MANUFACTURING INDUSTRIES

THE PRECEDING chapter has been devoted to a study of factors that influence the location of manufacturing industries. This and the following chapter will be devoted to an analysis of six important industries of the United States to exemplify the rise, changes in location or character, or decline of specific industries due to complex influences.

Flour Milling

The grinding of grain for the production of flour is one of the oldest "factory" industries. The most primitive method was the pounding by hand of kernels of grain between two stones, and, later, the use of a hollowed-out stone mortar to hold the grain while it was pounded with a stone pestle. It required so much time and labor to grind, sift, and grind over again the grain for even one meal that there was tremendous impetus to find some way of doing the job more easily and quickly. The solution discovered was so simple and effective that it is still in very wide use. Two flat circular stones of considerable hardness were each fluted on one surface in a design like the spokes of a wheel. The two stones were then placed with their dressed or fluted faces together, one on top of the other. By means of a shaft, the upper stone was made to rotate. Power was supplied by animals, windmills, or water. The grain was poured into a hole near the center of the upper stone, and as it was crushed and ground between the stones it worked its way out to the edges It was then sifted and the coarse parts reground. The distance between the stones, the nature of the stone itself, the nature of the face, and the speed with which it turned were all important considerations.

From earliest Colonial times such mills were widely scattered over the United States (except in the South, where cheap labor and a preference for corn meal existed), and grain was ground for local consumption and for export. With the settlement of the Middle West, flour mills were established in river cities like Cincinnati and Louisville and stimulated a large trade because of cheap water transport for grain and flour.

Up to about 1830 settlement spread over territory suited to the growth of soft winter wheat and the flour was ground with techniques suited to that grain, which was low in gluten. Gluten is what makes dough hold together in fermentation, and a high gluten content enables the baker to make a light raised bread, fine in texture. As a result, bread in those days tended to be heavy and coarse. When northern Illinois and Wisconsin were settled, it was found that in that climate hard spring wheat was much more dependable than winter wheat, and as the frontier passed beyond Minnesota and the Dakotas a tremendous area suited to the growth of hard spring wheat became available.

Stone milling, however, was poorly suited for handling hard spring wheat, whose hardness caused the generation of considerable heat in the grinding process and this discolored the flour. By setting the millstones farther apart, cleaning the poorly ground product and remilling it, the millers of the Spring-wheat Belt managed to make a good flour which was sold even in eastern markets. This hard wheat flour was "stronger," that is, its higher gluten content permitted more raising of the bread and allowed more bread to be baked from the same amount of flour.

The problems raised by the hardness of spring wheat and the origin in Europe of some of the ideas for cleaning and purifying the flour brought the attention of Minnesota millers to European methods. They found that Hungary, also a hard-wheat country, had developed an entirely different milling process suited to hard grain. This technique was introduced into this country in 1873 and with its American adaptations is now the only important commercial milling process in this country. It substituted a series of fluted rollers instead of stones for crushing and grinding the grain. The grain was dampened and passed through relatively widely spaced rollers which squeezed the grains apart; then it passed through still other sets of rollers, each of which was set a trifle finer, with the appropriate screening or drying between each set.

Dominance of the Minnesota District. By 1880 the superiority of bread flour made from high-gluten spring wheat was accepted throughout the country. The Spring-wheat Belt of Minnesota, the Dakotas, and Montana had an apparent monopoly of the raw material within the American borders. It takes about 270 pounds of wheat to make a 196-pound barrel of flour, so flour milling tends to locate in the center of wheat production rather than close to market, other factors being equal. Consequently the Minnesota District—and especially Minneapolis, which was a railroad center and had cheap water power—became the dominant flour-milling district and remained dominant until 1925, although after 1905, its share in total production declined steadily.

Rise of the Kansas District. From the early days of their settlement Kansas and Nebraska grew soft winter wheat and milled it for local consumption and for sale, especially in the South. However, the competition of quality flour from the Minnesota District precluded any great expansion of their market. In the early 1890's a hard variety of winter wheat was introduced into this area and was soon grown in tremendous quantities This hard winter wheat made almost as good flour as the hard spring wheat, and the price was usually lower. Wheat yields in the Spring-wheat Belt declined because of influx of weeds, pests, diseases, and the exhaustion of seed and soil. All this made wheat from the older areas of the Northwest more expensive and gave an advantage to the new soils and expanding acreages in the Kansas District. Hard winter wheat growing expanded into ever drier and cheaper lands in Oklahoma, eastern Colorado, and the Panhandle of Texas The principal railroad centers throughout the district—Omaha, Dallas, Wichita, Salina, Hutchinson, Oklahoma City, and above all, Kansas City, Missouri—grew into large milling centers. By 1925 the production of this district had surpassed that of the Minnesota District and it now leads, producing about one-third of the bread flour in the country.

The Rise of Buffalo. Western New York and especially Rochester and Buffalo have been engaged in flour milling from the 1820's to date. They lie between the western grain regions and the eastern export markets; they have cheap water power, while the Lakes and Erie Canal and the railroads have given them low freight charges Before about 1905 these advantages did not affect the reputation of Minnesota millers for high quality flour or disturb their control over the best bread wheats. But since that date the production of hard spring wheat within the United States has declined pretty steadily, and the production of hard winter wheat has grown at an astounding rate. The Buffalo district was much more favorably situated to get this wheat cheaply than was the Minnesota District, and it was also favored by "milling in transit" and "milling in bond" privileges.

Milling in Transit and Bond. The freight rate structure in the United States has usually given lower rates to wheat than to flour. The "milling in transit" arrangement allows wheat to be shipped from point of origin, milled somewhere along the way, and the flour shipped to its destination at the same price which would be charged for a cargo of wheat shipped over the same distance without interruption. Buffalo's easy access to wheat from the hard spring and hard winter wheat district and its location on the route to northeastern markets, made this arrangement especially advantageous.

"Milling in bond" is an arrangement whereby wheat may be imported in bond, milled in this country, and the flour reexported without payment of tariff. Because much Canadian grain comes down the Lakes from the great spring wheat area of the Prairie Provinces, this privilege also reacted strongly in Buffalo's favor. Another favorable consideration was the large market which exists in the dairy and general farming regions of the northeast for cattle, chicken, and hog feeds produced as a by-product of flour milling.

Throughout most of the recent history of the industry the American tariff has practically excluded Canadian wheat from American mills except for milling in bond at Buffalo. The spring wheat of the Prairie Provinces would have been the logical source of supplies for the Minnesota District when its own supplies began to dwindle. This wheat is usually cheaper than American wheat of the same quality and railroad rates in Canada on wheat are generally lower.

Today the Kansas District is the leader in production of bread flour and promises to continue so, the Minnesota District is second and continues to decline, the Buffalo District is third, but continues to grow rapidly

Scattered Milling. Another milling district of some importance is that in the port cities of Washington and Oregon. The moist coastal valleys produce soft winter wheats, but hard wheats, both spring and winter, are grown in the drier interior, especially in the Columbia River basin. In addition the railroads some years ago reduced the rate on hard spring wheat

from the western half of Montana to the Pacific Coast provided it, or the flour made from it, were billed for export. This has resulted in the drain of most of this wheat to the Pacific Coast rather than to the Minnesota District. A large local consumption and export trade with the Orient are the main outlets of the Pacific Coast millers.

Soft winter wheats are still milled very widely for local use and for the making of pastry flour for which they are eminently satisfactory. The local miller has in many instances a price advantage over the big millers, although his product may fluctuate considerably in quality. About half the states produce over one million dollars' worth of flour apiece in the average year, and it is estimated that about 35 per cent of the nation's output is produced in scattered mills.

QUESTIONS FOR DISCUSSION

1. What foreign cities are noted as flour-milling centers? What is the major factor in the location of flour mills?
2. Does the location of sawmills resemble the location of flour mills? Why?
3. Review the material on wheat varieties in Chapter 18.

Woolen and Worsted Manufacturing

The manufacture of wool fiber into yarn and cloth is an old industry. As was pointed out in Chapter 35, early textile machinery was developed in this industry before the invention of the cotton gin made cotton the cheaper fiber. As an old industry, it has tended to cling more to tradition, to retain more of the skill of the individual worker, and to remain in the traditional centers.

The Early Woolen Industry in the United States. The colonists brought their cards, spinning wheels, and looms from the mother countries and carried on the household industry of making woolen cloth. Sheep were widely grown and weavers were widely scattered, at first, approximately in proportion to population. Only "fulling" or the shrinking and finishing of cloth required power operations. A few "factories" in which a battery of hand looms was collected existed in seaboard centers even before the American Revolution and produced enough surplus cloth to alarm the British manufacturers. The first power loom was installed in 1788, but growth of the industry was slow until the War of 1812 cut off supplies of woolen cloth from England and caused a boom. This collapsed, however, when British manufacturers "dumped" their product here after the war, and a demand arose for a tariff to protect the infant industry. From 1816 on the industry has operated almost continuously behind a protective tariff wall.

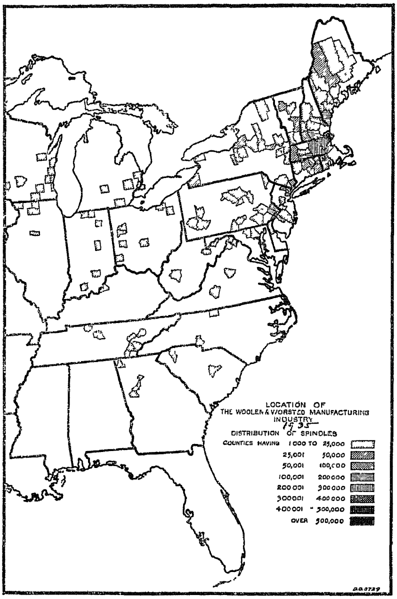


Fig 208. The importance of skilled labor in the woolen industry is shown by the failure of this industry to move southward. (Courtesy of the U. S. Department of Commerce)

Raw material has always been a problem for the American woolen industry. Wool from domestic sheep of English breeds in Colonial times was unsatisfactory and led to the introduction of the Merino in 1790. When the industry began to grow after 1820, it became necessary to import wool. As the country grew, high labor costs, greater demand for other uses of the best sheep-raising lands, and an emphasis on meat breeds rather than wool breeds continued to make American wool scarce, short in fiber, and expensive. Today this country imports about 20 per cent of its clothing wool. In spite of this shortage, wool producers have been protected by tariff almost continuously since 1824.

Factory manufacture of woolen cloth began, as did most early American manufactures, in New England and spread to New York, New Jersey, and Pennsyl-

vania. These areas had seaboard positions which gave them access to markets of the South and the West Indies and to wool from overseas. Skilled immigrants provided the labor, and capital and market were at hand. With the settlement of the interior small woolen manufactures grew up there and still exist, but they never had the growth characteristic of factories in the old centers. The tremendous demand for uniform cloth during the Civil War hastened the completion of the mechanization of the industry.

The Worsted Industry. In the manufacture of woolen goods, a variety of fiber lengths is used, including many of the shorter lengths. The yarns used are rough to the touch because fiber ends protrude and the resultant cloth is rough and loosely woven Worsteds, on the other hand, are made of longer fibers, the yarn is spun tightly, and the cloth is closely woven and much smoother. Before about 1850 worsteds were very expensive and were seldom manufactured in this country because of the amount of labor required in combing out the longer fibers by hand and the extra processes necessary to spin a tight, fine yarn. Just before the Civil War mechanical combs were developed and worsteds became cheaper. By 1870 the worsted industry was well under way and has assumed a growing importance until it is now about equal to woolens in yardage of output, and, because of the higher price per yard, is of much greater value.

The reasons for the growth of the worsted industry are several. The mechanical comb and other technical improvements made worsteds cheaper. The growing urbanization of the nation and higher standards of living gave rise to a demand for lighter and better-looking cloth. The rise of factory production of both men's and women's clothes also called for lighter and fancier goods. Breeding of sheep for long fiber made the raw material available.

Location. The worsted industry developed in the old woolen manufacturing centers of the New England and Middle Atlantic states and has remained even more closely concentrated there than has the woolen industry. Skilled labor is much more important in these industries than in cotton textiles, especially in the sorting, carding, blending, and weaving of wool, and they have not tended to follow cheap labor to the South In recent years Massachusetts has produced about one-third of the value of all woolen and worsted manufactures—Rhode Island, Pennsylvania, New Jersey, Maine, Connecticut, and New York ranking next in the order named. Together they produce about 80 per cent of the total.

QUESTIONS FOR DISCUSSION

1. Why has the cotton textile industry become more wide spread than the woolen and worsted industries?
2. Does the manufacture of silks resemble the cotton, worsted, or woolen goods industry? Why?
3. Account for the good reputation of the British Isles in the production of high-grade woolens and worsteds.

Men's Clothing Industry

The making of men's clothing[1] became a factory industry within the last seventy-five years. Previously clothing had been made in the homes or for neighborhoods in merchant tailoring shops. Large commercial cities with their access to style information and the large number of men who come to the city periodically on business had specialized tailoring districts which had more than their proportionate share of the trade The product had to fit an individual customer so tailors had to be where the customers were. It was considered impossible to conduct the industry on a factory basis because it was assumed that the individual customer had to select style, weave, and fit before the garment was made. This merchant tailor system prevails very largely today in Europe; indeed, no other country has as highly industrialized a men's clothing industry nor makes such excellent ready-to-wear garments as the United States.

Background. The Civil War which gave impetus to so many American industries made this industry possible. Before the war was over more than a million men of the Northern armies alone had passed through the hands of the military tailors. This was the largest body of men ever to be measured in any four-year period, and by carefully keeping their measurements, and supplementing them later, it was possible to arrive at a standardization of sizes which satisfactorily fitted most men.

Several other factors were of considerable importance. The sewing machine had been developed shortly before the war and made the time-consuming process of stitching long seams much shorter. Later, special machines were developed which sewed on buttons and did buttonhole stitching. Then mechanical cutters were invented which allowed one operator to cut out a large number of pieces of cloth to the same pattern at one time.

The availability of the labor supply was of perhaps even greater importance. After 1848 political and economic unrest in Europe drove a large number of

[1] Includes the manufacture of ready-to-wear suits, topcoats and overcoats, but not furnishings—such as shirts, scarves, etc,—nor work clothes and sports clothes.

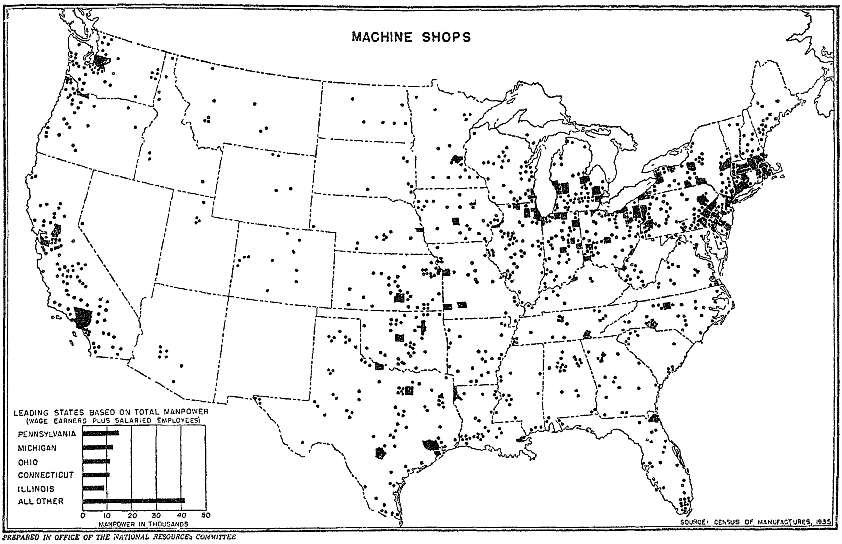


Figure 209 Machine shops provide a necessary service to almost every type of industry (Courtesy of the National Resources Committee)

immigrants to this country. These disturbances, and especially persecution of the Jews, bore heaviest on the city dwellers. Many of the exiles were urban workers, and among them were large numbers of tailors. They settled in American cities, especially New York, and made available a cheap and partially skilled labor supply.

Distribution of the Industry. The immigrant labor supply, the necessity of keeping in close touch with style factors, the advantage of being in the heart of the market have all tended to make this a characteristic industry of larger cities of northeastern United States. No great amount of space or power in proportion to the value of product is required, and woolens and worsteds are manufactured close at hand.

The State of New York predominates with 43 per cent of the production by value. Of this, New York City alone contributes the bulk, with Rochester supplying most of the small remainder. Philadelphia, Chicago, Cleveland, Baltimore, Boston, and Newark are the other important centers.

The organization of the industry varies in these centers. In New York the industry is largely composed of small shops set up in rented loft space. The industry is subdivided into many special branches. There are numerous "contractors" who do special cutting or sewing jobs on material furnished by jobbers or manufacturers A jobber is one who makes no garments himself, but has them made up to his patterns in his material by contractors. A manufacturer buys his cloth and carries on some or all of the operations himself. The jobber-contractor relationship allows for rapid adaptations to volume changes and is admirably suited to conditions in this, the style center of the nation. In Chicago the complete "inside" shop, housed in a large building erected for the purpose, is characteristic. The other centers have both "inside" shops and the jobber-contractor setups in varying degrees.

QUESTIONS FOR DISCUSSION

1. To what extent does the women's clothing industry resemble the men's clothing industry? How are they different?
2. To what extent is ready-made clothing ready to wear? In what ways is it altered to suit the peculiar requirements of the customer? Is it possible to avoid such alterations?

CHAPTER 37

SOME AMERICAN MANUFACTURING INDUSTRIES (*Continued*)

The Machine Tool Industry

THIS industry probably represents the ultimate in industrial maturity A region or a nation possessing high standing in machine tool design and production has carried human mechanical ingenuity to the highest point yet achieved. In economics, too, such a region has achieved the ultimate in "roundabout" or "indirect" production, for this industry produces many machines which are used only to manufacture other machines.

A machine tool is technically "a power-operated metal-working machine, not portable by hand, having one or more tool and workholding devices used for progressively removing the metal in the form of chips "[1] Thus lathes, planers, boring machines, and milling machines not only are used in shaping of metal parts for a wide variety of machines from clocks to locomotives, but are the agents by which other machine tools are made.

The machine tool is created to meet a need and the manufacture of such tools is therefore concentrated in countries which are or have been developing new machines and new processes. Their design and production also require great technical knowledge and skill, which further limits their production to manufacturing countries such as Great Britain, the United States, Germany, Sweden, and France.

A Typically "American" Industry. Historically, power-driven machine tools on a modern scale were first successfully developed in Great Britain to make the machinery necessitated by the mechanization of industry. However, these merely represented the application of power to tools which were in principle much the same as the hand tools known for centuries.

It was American manufacturing which most successfully developed the system of making large numbers of interchangeable parts capable of being assembled into complete machines. First applied successfully in this country to the manufacture of firearms, this technique was later applied to clocks, sewing machines, and more recently to the automobile and a host of other machines. For a long time labor was scarce and opportunities for employment were many. The growing population and large size of the country created a large enough market to pay the manufacturer to invest large sums in special machines designed to do nothing but make parts for other machines, such as watches or automobiles, which were consumed by the public. Interchangeable parts made automatically in large quantities to exact specifications provided dependable mechanical goods that were cheap and easy to repair, as a result, Colt revolvers, Singer sewing machines, Ingersoll watches, and International harvesters, to mention but a few, have been sold in every corner of the world. This whole type of manufacturing has grown to be so distinctively American that it was known for a long time in Europe as "the American System."

Jigs, Fixtures, and Gauges. The manufacture of interchangeable parts led to the invention of certain distinctive and significant parts in machine tools. Jigs and fixtures, devices for holding work in place and guiding cutting tools, are so constructed as to be suited to the manufacture of one specific part only. They eliminate that intricate "setting up" of work which, in a general machine shop, requires a skilled mechanic and considerable expenditure of time. Jigs are usually associated with boring machines, fixtures with cutting machines, although the terms "jig" and "fixture" are sometimes used interchangeably. Once the block to be worked on is locked in the appropriate jig or fixture, the operator steps on a treadle and the machine does the rest, performing an operation which will exactly duplicate the operation it has performed on thousands of similar parts before. Gauges are devices for testing whether a given part is exactly up to specifications.

It can be seen that a change in model will render many or all of the jigs, gauges, and fixtures useless and require the "re-tooling" of a whole manufacturing

[1] The definition of the National Machine Tool Builders Association quoted in Glover, G. G, and Cornell, W B. (Editors), *The Development of American Industries*, New York, Prentice-Hall, 1936, p. 495.

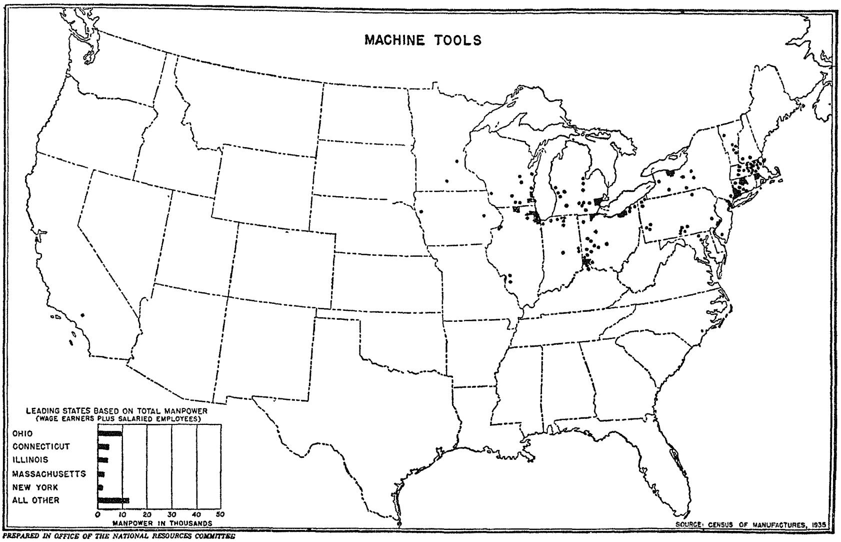


Figure 210 Compare with Figure 209 Why is the machine tool industry so much more concentrated than the machine shops? (Courtesy of the National Resources Committee)

plant. In 1927, for instance, when the Ford Motor Company changed from the Model T to the Model A, it shut down its operations for five months and scrapped or altered about 70 per cent of its machinery.

Locating Factors in the Industry. Special machines that are to be made parts of still other machines are usually designed and produced in or near the regions most concerned in machine manufacture. When in 1798 Eli Whitney of Connecticut decided to produce muskets consisting of interchangeable parts, he had to design and build suitable machine tools. Other infant American industries also designed their own machine tools, though a separate industry for their manufacture did not really develop until shortly after the Civil War. In the meantime, techniques were developed and workmen trained so that New England and the Middle Atlantic states were ready to cope with the problems to be raised in the days to follow. When large-scale manufacturing developed in the Middle West, machine tool manufacturing—usually with Eastern-trained mechanics and engineers—sprang up to meet the demand.

Raw material costs are of no importance in the location of machine tool manufacture. While larger machine tools require considerable quantities of high-priced special metals, often secured from distant sources, the value of metal is slight in comparison with the value added by engineering knowledge and mechanical skill. Power, too, though absolutely necessary, accounts for little of the cost of manufacture.

Highly skilled labor and great sums of capital are vital necessities in any modern machine tool industry. While highly mobile, they are most likely to be found in or near the market where manufacturing is most highly developed. When a manufacturing region is new, it imports its machine tools. If it develops its own machine tool manufacture, it is a sign that the region has "grown up" industrially.

Eastern Machine Tool Manufacture. As indicated earlier, the first application of machine tools to manufacturing in this country was in Connecticut. New Haven, Bridgeport, Hartford, and New Britain were early leaders in machine operations, and plants for making machine tools to supply their needs grew up in and around these cities. In Rhode Island and

Massachusetts, Providence, Worcester, Lowell, and Springfield also became important Even more remote Manchester and Nashua, New Hampshire, and Windsor, Vermont, had significant machine tool building plants. The New England States still manufacture between one-third and one-half the value of machine tools in the country. This industry with its emphasis on skill, tradition, and capital rather than on power or raw materials is well-suited to these states.

The Middle Atlantic States also entered machine tool manufacture at an early date Pennsylvania, New York, and New Jersey had easier access to coal and raw material than New England. The manufacture of textile machinery and locomotives, and the shipbuilding which grew up here with the shift to iron and steel ships, gave rise to a specialization in the manufacture of heavier machine tools, such as giant lathes for turning down drive shafts for ships and locomotives or giant planers and milling machines for making ship and engine parts. However, this region never achieved the importance of New England in this industry.

The Middle West. By 1880 Ohio had begun to assume importance in manufacturing and, with Illinois, Indiana, and Michigan, had started important machinery manufacturing, especially in agricultural machinery, farm tools, and hardware for the great Western market. Cincinnati and Springfield, Ohio, Rockford and Chicago, Illinois, Detroit and Grand Rapids, Michigan; Milwaukee and Madison, Wisconsin; Indianapolis, Indiana; and St. Louis are the great Middle Western centers. Most of them were started with mechanics and engineers trained in New England plants, and some were started as branches of New England enterprises.

The Middle West is now the dominant machine tool manufacturing region While many other machine industries supplied the demand at the start, since 1910 the automobile industry has caused the tremendous growth which gives the region its present ascendency. The automobile industry has carried the automatic manufacture of interchangeable parts to its highest degree and has served as the greatest market for machine tools. With the automobile industry concentrated largely around the western end of Lake Erie and the southern end of Lake Michigan, it is not surprising that today Ohio and Illinois are the leading machine-tool manufacturing states and, together with Michigan, Indiana, and Wisconsin, supply more than half the value of machine tools manufactured in this country.

QUESTIONS FOR DISCUSSION

1. Use the machine tool industry to illustrate these terms: *standardization, interchangeability, localization of industry, decentralization of industry.*
2. Do you expect a further decline of New England in its share in the American machine tool industry? Why?
3. Do you expect the Southern Piedmont to become an important center for machine tool production? Why?

The Automobile Industry

The peculiar contribution of the United States to the whole theory and practice of manufacturing has in no industry been more marked than in the automobile industry Automatic machinery has been applied on a large scale to the manufacture of interchangeable parts to standardize and lower the cost of the product and enable it to find the largest possible market.

Up to 1890 the development of road vehicles driven by internal combustion engines had taken place exclusively in Europe. It was in 1892 that Charles E. Duryea built the first practical car in the United States. He was followed by Ford and Olds who had experimental cars on the road in 1893 From 1900 when 4192 cars and trucks were produced, the industry grew until in 1929, when American and Canadian factories produced over 5,500,000 vehicles, the maximum production was attained. By 1935 the industry had recovered in large part from the general depression and every year since close to 4,000,000 vehicles have been produced. The total number of vehicles in use at present in the United States averages one car for approximately every 4.3 inhabitants. No other large nation in the world approaches the United States in the use of motor cars, the nearest being New Zealand with one vehicle for every 6 persons.

Causes for American Supremacy. There is much in the physical environment of the United States to encourage motor car use. This is a large country with great distances to overcome. Raw materials such as iron and copper are abundant and cheap, and no other large manufacturing nation has had such cheap petroleum with which to lubricate and propel its vehicles.

In addition, the market has been a growing one, not only in terms of mere numbers of people but also in terms of income per capita. In the whole history of the industry there has been an interplay of forces, each acting sometimes as cause and sometimes as effect. Size of the potential market made mass production possible, but mass production lowered the price of the cars and increased the market. Automobiles

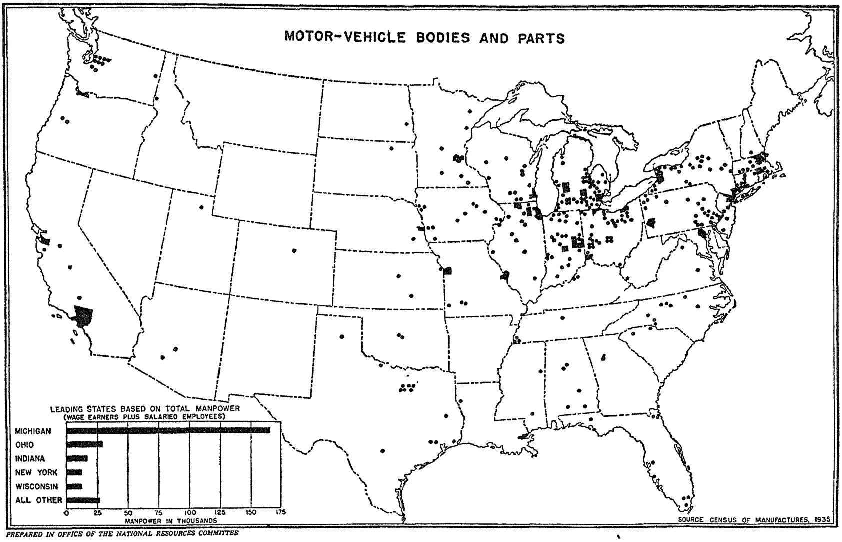


Figure 211. The automobile industry is concentrated around the lower Great Lakes but its assembly plants and the manufactures of its parts are distributed throughout the industrial regions of the United States. (Courtesy of the National Resources Committee)

called for good roads designed to accommodate the weight and speed of the new vehicles, and good roads made the use of motor vehicles ever more popular

Size of the Industry. If "the automobile industry" is taken to mean all those manufacturing operations which go into the making of the finished car or truck, there is no doubt but what it is the nation's largest industry. It is almost the sole consumer of the products of the great rubber tire industry and the leading consumer of plate glass, nickel, lead, upholstery leather, and iron and steel. Since many of the great automobile corporations produce many of these products solely for use in their own cars or trucks, a large part of each of these industries may rightly be included in the scope of the automobile industry. The automobile looms so large in American economic life that an estimated one-tenth of the national income is spent in purchasing, operating, storing, servicing, and insuring automobiles.

Organization of the Industry. Not only is the automobile industry the largest in the United States, but many of its component companies are also of tremendous size. Ten companies produce 95 per cent of all cars sold. All assemble their own cars and almost all make their own engines, though the extent to which they make the other parts which go into their cars varies The Ford Company owns outright iron ore, coal mines, and forests, and owns either entirely or in part plants manufacturing tires, glass, and a host of other parts used in its cars. The General Motors companies include a wide range of subsidiaries and there is a great deal of inter-company business, but neither they nor the other companies included in the ten largest are as extensively integrated as Ford. The automobile manufacturer is constantly faced with the question as to whether he shall make or buy a given part, and at different times and in different companies the answer has varied. In general, however, the recent tendency has been to buy parts extensively because this places the capital costs involved in changes in model and seasonal demand more largely on the parts manufacturer rather than the automobile company.

If a car is to be made to sell inexpensively, it must be produced in large numbers to justify the great capital investment in plant, machinery, jigs, and fixtures. Only the low-priced car will reach a large

enough market to give the volume necessary to pay income on this great investment, so every manufacturer either makes at least one low-priced model or else is constantly trying to make his car cheaper to get a wide distribution. Packard, for instance, started in the high-priced field and is constantly putting on the market cheaper models to get more volume. Ford, on the other hand, started in the low-priced field and has invaded the higher-priced brackets to sell to wealthier consumers Chrysler and General Motors diversified their lines by taking in other companies. All these factors combine to make the tremendous units characteristic of the industry.

Location of Manufacture. The four Middle Western States, Michigan, Ohio, Indiana, and Illinois, supply more than 60 per cent of the value of all automobile manufactures, and Michigan alone supplies more than 50 per cent Only New York and California, with branch assembly plants in important market centers and favorable locations for export, are important among the rest of the states. This predominance of the Middle West in the industry has been characteristic almost from its beginning and is due to a combination of historical, psychological, and natural causes.

In the 1890's the machinery industry of the Middle West was new and growing and attracted to it men of imagination and ingenuity. Ford, Olds, Buick, King, Leland, and others in this region experimented with the idea of the horseless carriage and were willing to risk time and money in such a new and speculative venture. They built automobiles and found that their location was for a number of reasons eminently suited to production Iron, copper, and coal were near at hand or readily accessible, and the Lakes region supplied the hardwood timber used extensively in the earlier bodies. They also found that they were located almost at the exact geographic center of population in the United States and could cheaply reach the whole market. The farm-machinery, wagon, bicycle, and machine-shop industries already at hand supplied the necessary corps of trained mechanics. Once established and successful, all the advantages of localization (see page 300) came into operation and became cumulative.

It must be borne in mind in any statistical analysis of automobile manufacture that this is predominantly an assembly industry. That is, parts—some manufactured by the automobile companies close at hand and some bought from distant manufacturers—are combined progressively on a moving assembly line to make a finished car. To the finished car these parts are raw material, but many are the finished products of other industries and may be made by companies not classed as "automobile manufacturers." Thus, the "automobile industry," in its broader sense, is much more widespread than is usually recognized and may include the manufacture of electrical equipment in Connecticut, of wheels in Pennsylvania, or paint in Missouri These factories are not included in census figures unless they are owned outright by the automobile company.

Branch Assembly. Because of certain characteristics of the freight rate structure, an assembled automobile is more expensive to ship, due to its bulk, than are the parts necessary to make it. In addition, as has already been indicated, parts manufacture is widely distributed. Consequently, some of the largest companies, especially Ford, have found it economical to establish branch assembly plants in market centers distant from the Middle West. Los Angeles, California; Atlanta, Georgia; Edgewater, New Jersey; and Chester, Pennsylvania, are examples. This dispersal of assembly plants has in turn some tendency to disperse parts manufacturing because of savings on shipping charges.

The foreign market is often supplied largely from branch assembly plants located in or near principal ports or from branch factories established abroad. Import duties on parts are lower in most countries than on finished cars and branch assembly abroad may be economical for this reason.

QUESTIONS FOR DISCUSSION

1. Look up in the *Statistical Abstract of the United States*, the *Census of Manufactures*, or in some other statistical source, the location of the other vehicle industries How does their location compare with the location of the automobile industry? Explain
2. Do you anticipate further localization or further decentralization in the automobile industry? Why?

The Baking Industry

The machine tool and automobile industries previously discussed in this chapter are among the newest industries, not only as regards organization, but also in reference to the demand they meet. The baking industry also is new as a factory industry, though it supplies a product which has been in demand for ages and which was formerly produced only in home kitchens.

This industry has two main divisions: the "soft" baking industry—producing bread, pie, and cake—

which has highly perishable products and is composed of a large number of widely distributed establishments, and the "hard" baking industry—producing crackers, hard biscuits, and cookies—which has less perishable products and fewer and, on the average, larger plants, less widely distributed.

Evolution of the "Soft" Bakery. Baking of bread was once, like cooking, an operation carried on in every kitchen and this situation still prevails in most of the world. But the baking of good bread under kitchen conditions requires skill and is as much an art as a science. Any product which, like "raised" bread, depends on quick fermentation is subject to many variables. The weather, the quality of the particular batch of flour or yeast used, the state of the fire, all vary, and the housewife usually says she "had good luck" with her bread if it is perfectly satisfactory. The baking of cake and pie in the kitchen is only slightly less precarious, but here success depends more on the way in which the ingredients are combined than on "luck."

Where people lived in large enough groups, neighborhood bakeries often sprang up to take over the production of these products, whose creation in the kitchen was so uncertain and consumed so much time and fuel. The baker was skilled and bought his flour and yeast in large quantities. But because his product was perishable, he served a small neighborhood and his bakery was small.

Increasing urbanization and speedier transportation, however, have made it possible to serve a larger market from a single plant and, therefore, to have larger bakeries. Apartment living with its smaller kitchens, the higher living standards which tended to make many women dislike kitchen work, the shortage of good and cheap servants in many parts of the United States, and the growing employment of women in industrial and clerical pursuits also helped to increase the market.

The large bakery has many advantages which the housewife and the neighborhood baker never had. It can buy flour, yeast, and other ingredients cheaply in large lots and according to standard specifications. It can store them under conditions of absolutely controlled temperature and humidity, control the quantities by weighing, mix them thoroughly by machinery, and bake them under controlled conditions in large lots. Each kind of product is uniform and may be bought with confidence.

Geography of Commercial "Soft" Baking. There are approximately seventeen thousand commercial bakeries reporting to the Bureau of the Census. In general, they are distributed according to density of population. The urbanized Northeast has slightly more than its proportional share. The rural South has less than its proportional share not only because population is scattered, but also because hot corn breads are popular, servants cheap, and incomes low. Growing industrialization, better roads, and the increasing importance of the grocery chains which distribute bakery products from their own plants are gradually changing this condition in the South.

"Hard" Baking. This branch of the industry is in its factory form older than the other. "Ship's biscuits," crackers, and other similar almost indestructible products were baked in factories at an early date and distributed to a very wide market. Arctic explorers carried biscuits enough for several years, and the cracker barrel was a fixture in the country store by the time of the Civil War In contrast to the 17,000 establishments in "soft" baking, there are but 300 in this branch. They are concentrated in great wholesaling centers. Competition is keen and there is a large amount of national advertising. The average plant in this branch of the industry employs about eight times as many workers as the average in the "soft" industry and produces about nine times the value of product. Two companies with a large number of strategically located plants account for approximately 70 per cent of the total business.

QUESTIONS FOR DISCUSSION

1. Cooking is still largely a home industry. Do you expect it to develop further as a large-scale, factory industry? Do you think it will ever become as great a factory industry as the baking industry? Why?
2. What determines the maximum size of the market of a unit in the "soft" baking industry?

REVIEW QUESTIONS ON PART FOUR

1. Check list of new terms:

liner	metropolitan district
tramp steamer	industrial area
coastwise traffic	regional planning
trunk route	interchangeable parts
harbor	division of labor
port	geographical division of labor
entrepôt	economic nationalism
free port	industrial inertia
hinterland	localization
head of navigation	decentralization
internationalized river	
great circle route	

2. Under what conditions and to how great an extent is a seaport justified in offering tax exemption and similar favors as an inducement to new industries?
3. Should world trade increase or decrease in the next century? Should the proportion of people living in the cities increase or decrease? What are the factors involved?

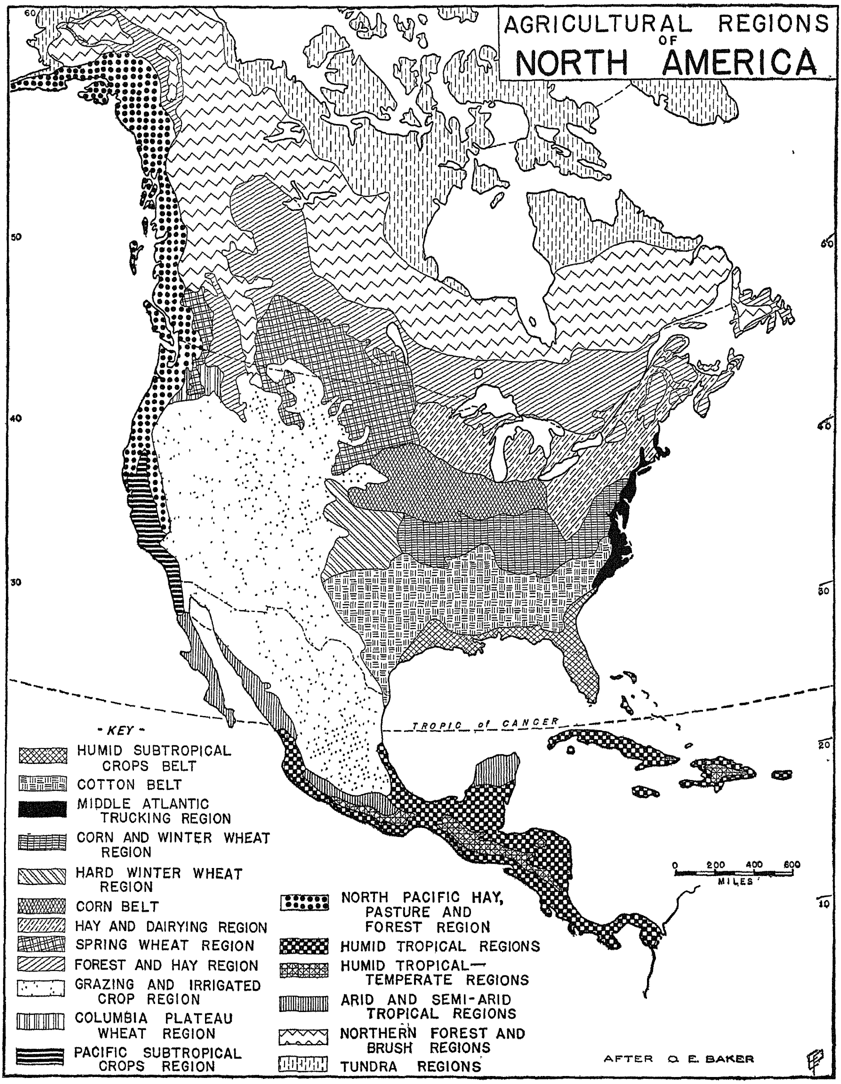

AGRICULTURAL REGIONS OF NORTH AMERICA
- KEY -
HUMID SUBTROPICAL CROPS BELT
COTTON BELT
MIDDLE ATLANTIC TRUCKING REGION
CORN AND WINTER WHEAT REGION
HARD WINTER WHEAT REGION
CORN BELT
HAY AND DAIRYING REGION
SPRING WHEAT REGION
FOREST AND HAY REGION
GRAZING AND IRRIGATED CROP REGION
COLUMBIA PLATEAU WHEAT REGION
PACIFIC SUBTROPICAL CROPS REGION
NORTH PACIFIC HAY, PASTURE AND FOREST REGION
HUMID TROPICAL REGIONS
HUMID TROPICAL—TEMPERATE REGIONS
ARID AND SEMI-ARID TROPICAL REGIONS
NORTHERN FOREST AND BRUSH REGIONS
TUNDRA REGIONS
TROPIC of CANCER
0 200 400 600
MILES
AFTER O. E. BAKER
60
50
40
30
20
10

Figure 212.

CHAPTER 38

THE CONTINENT OF NORTH AMERICA

The Regional Idea. In Parts Three and Four, occupations were considered individually, and, of necessity, much was omitted that was part of the total geographic situation. But the producer is concerned not only with his particular business or occupation, but with the whole economic structure of the region in which he operates. Business enterprises compete with one another for markets, labor, raw materials, capital, and sites. Furthermore the workers in each enterprise provide an important market for neighboring enterprises Thus, to portray fully the geographic background of business, the regional as well as the industrial settings must be described.

In Part Five, the major facts about the regional settings throughout the world will be outlined. Immediately, there arises one of the major geographic problems: How shall the world be subdivided and on what basis shall its regions be delimited? Usually a region is defined as an area throughout which one or more features commonly occur. Obviously, there may be a multitude of regional divisions, for the common features may be environmental, economic, political or social, or a combination of these. The regions used in the following chapters are not based on any one feature or on any one combination of features. Each regional unit presented has some significant common feature (or features), which seems to the authors to differentiate it from surrounding areas. In more detailed treatment, these major units are then subdivided into smaller regions, each of which has its own basis for unity. This subdivision could be repeated many times, but, for obvious reasons, an introductory text should not carry it too far, otherwise the broad picture may be obscured by a wealth of details. Thus even the smallest units described here contain much variety, which would have to be considered carefully in a more detailed regional study. The final criterion in regionalization is, therefore, convenience rather than complete, detailed accuracy in delimitation.

Time, People, and Environment in North America

A unique combination of history and physical environment has caused the North American continent to be the stage on which the forces set loose by the Renaissance, the Era of Discovery, and the Industrial and Mechanical revolutions have had their fullest scope. Of all continents, North America alone had tremendous new areas suited to be the home of an active white population of European origin. The continent of Asia was already crowded; Africa is largely tropical or desert; South America is broadest in the tropics and only the narrow southern part and a few plateaus are "white man's country"; Australia is partly tropical and largely too dry for any intensive use. North America, however, had these advantages:

1. There were great areas of practically unused land in the temperate middle latitudes.
2. Much of it consisted of broad plains with an abundance of rainfall and good soil.
3. These plains were easily approached from the Atlantic or European side.
4. There was plenty of timber.
5. There was water power for the mills
6. There was a small and scattered native population (except in the area south of the Rio Grande), which was conquered with relative ease.

To the middle parts of this new continent Europeans could come in large numbers, bring their families, establish homes, and make a living with the same crops and animals they had used at home. In addition, they could employ new crops—such as corn, beans, squash, and tobacco—which had been domesticated by the natives. Large numbers did come and, gradually, over a period of a century and a half, they extended their settlements from the Atlantic to the Appalachians and, in Canada, up the St. Lawrence to the Great Lakes.

A political revolution and subsequent independence gave the young United States a new vision. The fruits of the Industrial Revolution gave it new

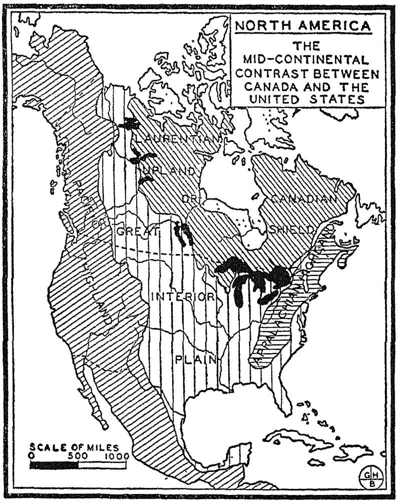


Figure 213. (Courtesy of *Economic Geography*)

tools with which to conquer the vast territories lying between the Appalachians and the Pacific. Thus the new nation soon extended its political sway from ocean to ocean and began to undertake public works, such as canals and turnpikes, to bind its parts together. The inventions and discoveries which were being made both in Europe and America were soon applied to a growing manufacturing industry, which supplied goods and demanded materials and power. River steamboats and, later, the railroads made possible the conquest of the great overland distances.

The people of the United States were not only advancing across the continent, but were carrying with them a new political, commercial, and industrial system. They found the continent ideally adapted to development under this system. The necessary power resources were present in abundance. Water power, wood, and coal drove the machines of the factories and the engines of steamboats and railroads. The metals required for industrial development were present in large quantities and further demonstrated the fitness of this continent to be the home of a great industrial and commercial society.

If any one of the elements in the combination of people, time, state of the sciences, or environment had been different, the results might not have been inferior, but they could not have been the same Canada, with similar people but a somewhat different environment and a slightly different political history, achieved similar results, but to a lesser degree and more slowly. The Spanish colonies south of the Rio Grande had an entirely different history because of a difference in type of European population, a difference in the objects of the colonial systems, a larger and different native population, and a less favorable environment.

The large land mass of the North American continent contains some of the largest free-trade areas in the world. If the settlement of interior North America had taken place in the days before the railroad and other rapid means of transport and communication made it possible for great areas of considerable diversity to be closely bound together, a multiplicity of small nations might have grown up, each in its own natural region and each setting up its barriers to trade.

Size. Third in order of size among the great land masses of the earth, with an area of approximately 9,000,000 square miles, North America is twice the size of Europe and half the size of Asia. From 7° north of the equator, it extends to 83° N., although the mainland only reaches to the 70th parallel. The distance from north to south is approximately 6000 miles, and from east to west (in the widest part) about 3000 miles.

In most respects this vast size has proven a decided advantage. It has been responsible for a great variety of climates, a multitude of types of vegetation, and an extensive coast line. The chief disadvantage of the continent's size is that much of its interior is a great distance from the ocean. This results in types of climate in the far interior which are characterized by aridity and extremes of temperature.

Structure. A continent, like an animal or a person, has a configuration governed largely by the nature of its skeleton. There are three main elements in the structural framework of the North American continent:

1. The great Western cordillera, high, broad, and relatively unbroken, consisting, generally, of two chains of young complex mountains inclosing a high arid and semiarid plateau.
2. The lower, narrower, and much less extensive Appalachian Mountain axis, extending from central Alabama to the Gulf of St. Lawrence as mature to old folded mountains.
3. The Laurentian Shield, usually a low, rough, much-glaciated land of old, worn-down mountains, swinging in a great arc from the coast of Labrador around Hudson Bay.

The way in which these elements affect the shape of the continent can easily be seen from the map (Fig. 213). The continuity of the Western cordillera close to the west coast results in the almost total lack of deeply penetrating arms of the sea on the western side of the continent. The swing of the cordillera toward the east as it proceeds southward accounts for the northwest-southeast trend of Mexico and Central America. South of central Mexico, the cordillera becomes lower and more interrupted. The interruptions at Tehuantepec and Nicaragua have developed interoceanic routes of travel by railroad, river, and lake. The low height of the mountains and their narrowness have led to the construction of an interoceanic canal at Panama.

The breadth, height, and continuity of the Western cordillera make it the great barrier of North America, and this barrier effect is added to by the general aridity of the region and by the deep young canyons cut into the intermontane plateau.

The Appalachian range is relatively short and low. Around its southern end, the Gulf of Mexico penetrates far into the interior, and the St. Lawrence-Great Lakes system offers a less open route around its northern end. The Laurentian Shield is an upland of old metamorphic rock which has been almost denuded of soil by glaciation. The moraines of the retreating continental glacier have formed a network of lakes, so it is estimated that as much as one-quarter of the area is water.

The land lying between these great continental "bones," and that to the east of the Appalachians, is, with a few exceptions, level or rolling. Sedimentary rocks, little altered by folding or volcanism, are the rule, and the minerals are limited to those ordinarily associated with such rocks: soft coal, oil, limestone, sandstone, shale, and others. All of the area has been uplifted, rather gently, and the rivers have somewhat dissected the former level. The distance to base level was so slight that this dissection has not generally produced land too rugged for agriculture. In addition, this slight topographic "aging" has been modified in the north by glaciation. It is this great level area which has contributed so largely to the rapid development of North America. Compared with large plains areas in other continents, it is remarkably fertile in soil, and most of its climates are well suited to an advanced agriculture.

Position. North America presents its most approachable side to the North Atlantic, across from Europe, whence have come the dominant people and ideas of the past three centuries The eastern part of the continent has an abundance of good harbors, and its low mountains are well back from the sea. The only easy paths to the interior open out from this coast because the greatest rivers flow into the Atlantic or its associated bays and gulfs.

The position on the Pacific has been of less importance in the past, partly because the general trend of settlement has been from east to west, and therefore the Pacific states are "newer." There are other important factors, however. The great Western cordillera acts as a barrier to easy access to the interior from the west. In addition, the Pacific is such a vast ocean that its great distances have acted as a barrier to trade and communication. It is much more significant, however, that it is only recently that the nations bordering on the Pacific have engaged in considerable commerce The growing "westernization" of crowded Asia has brought about this increase in recent years, and may have a marked effect on the future growth of the Pacific side of North America.

QUESTIONS FOR DISCUSSION

1. Why was the development of North America north of the Rio Grande different from that of the portion of the continent south of the Rio Grande?
2. When the American Indians occupied North America (probably by way of Alaska), they became divided into a large number of nations, each speaking a different language European settlers, on the other hand, formed relatively few political and lingual groups What geographical and other factors may account for this difference?
3. Compare Hudson Bay and the Gulf of Mexico as to their significance to the inhabitants of the continent.
4. How have relief, latitude, and ocean currents influenced the climate of North America? Review Part Two as it relates to North America

The Canadian Economy

Economically, Canada is a young country. Its leading industries, except in a small part of eastern Canada, are closely related to its natural resources. However, except in eastern Canada, its people are not numerous enough to develop its farmlands, its ores, and its forests. Canada's 3,500,000 square miles are inhabited by only 11,000,000 people. This population is, however, by no means evenly distributed over the country. There are four important areas of concentration, and one minor area. The first major area is in the Maritime Provinces (Nova Scotia, New Brunswick, and Prince Edward Island); the second is in the St. Lawrence Valley; the third in the Ontario Peninsula between Lake Huron and Lakes Erie and Ontario;

Figure 214 Each dot represents from 1000 to 2000 people. (Courtesy of the Dominion Bureau of Statistics)

and the fourth (with its people much more widely dispersed than in the previous three) in the Prairie Provinces of Manitoba, Saskatchewan, and Alberta between Lake Winnipeg and the Rockies. There is a minor area of population concentration in southwestern British Columbia, near and including Vancouver Nowhere except in the Prairie Provinces is there any considerable population north of the 50th parallel; most of the population is within less than four hundred miles of the southern border. Moreover, three-fifths of the people live in the two provinces of Quebec and Ontario, most of them within one hundred miles of the southern border.

Even within the populous areas, not more than a half day's journey by auto or train takes one to the economic frontier with its pioneer life. Pioneering in Canada, like most modern pioneering, is a search for new techniques to solve problems of climate and isolation. This country lies so far north, and its interior areas are so continental, that the growing season is short, and its winters, except on the Pacific Coast, are severe. Thus the variety of crops that can be raised is distinctly limited. The three leading crops (by area) were, in 1937, wheat (25,000,000 acres), oats (13,000,000 acres), hay and clover (about 9,000,000 acres). These are, it will be noted, all crops with a short growing season and relatively low rainfall requirements. The rainfall decreases rapidly from south to north in Canada (except on the Pacific slope), although the decrease in the rate of evaporation partly compensates for this effect.

The isolation of interior Canada is extreme. The great Western cordillera bars easy penetration from the Pacific, communication to the Atlantic by way of Hudson Bay is blocked by ice except for a few weeks each year, and even the St. Lawrence is closed by ice for nearly five months in the average year. The principal Canadian crops lend themselves to growth in regions isolated from market and are, therefore, a marked adjustment to this second element in the environment. Wheat usually finds a ready market abroad, and its value and relative imperishability enable it to stand even expensive land transport. The same may be said to a lesser degree of oats. The grasslands are used for the production of cattle and sheep products which also may be profitably shipped great distances.

In addition to the rigors of the climate and the isolation of its interior, Canada has handicaps of soil and topography. As is always the case in an area so far north and with such a low rate of evaporation, the podzolic soil is predominantly cold and sour, thus further limiting the amount and kind of crops Great areas between the plains and the Pacific Coast are mountainous while in much of the eastern interior, especially about Hudson Bay, the land, while seldom mountainous, is rocky or swampy. Only in the Prairie Provinces is the soil (chernozem) really fertile, while in a few eastern valleys—such as the upper St. Lawrence Valley and the Ontario Peninsula—it is of fair quality.

Canada is still a sparsely populated country. Of about 2,000,000,000 acres of land, only 163,000,000 (or about 7 per cent) are classed as "occupied." It is estimated that only another 200,000,000 acres can be classed as "potential agricultural land." But the best and most accessible land has already been occupied, and the "potential" land is usable only by discover-

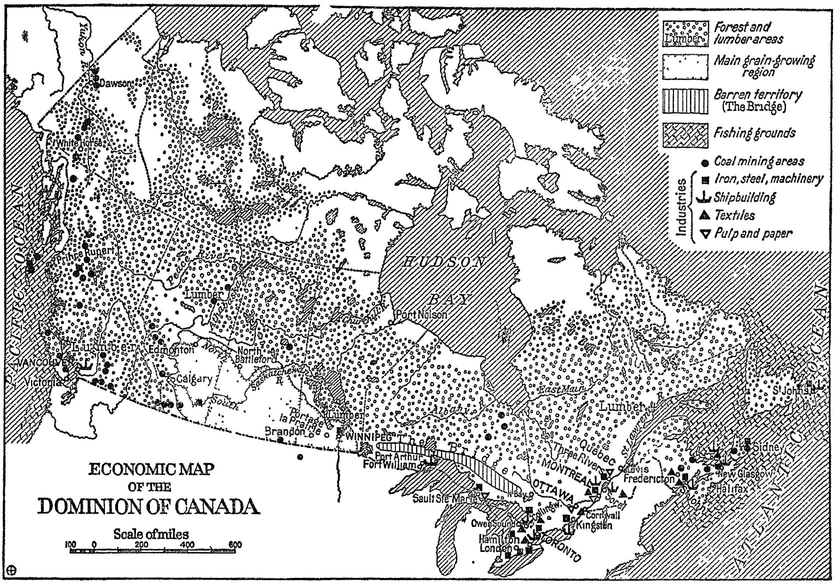


Figure 215. This map and Figure 214 suggest the spotty nature of Canadian development The coal symbols overemphasize the importance of Canadian coal Note that the well-developed region in southeastern Ontario is better able to obtain fuel from the Pennsylvania coal fields (From Isaiah Bowman, *The New World*, copyright 1928 by the World Book Co., Yonkers, N. Y. Reproduced by written permission of the publishers)

ing new crops or new techniques, building new arteries of communications, or finding new markets.

The Occupations and Foreign Trade. The occupations of the gainfully employed in any country throw considerable light on the economic life of the people. Figure 216 indicates that Canada is largely agricultural. In addition, the value of agricultural products exceeds the value of the products of all other industries. The type of agriculture in each part of Canada is very similar to that found in adjacent parts of the United States.

Canadian manufacturing is, likewise, almost a replica of manufacturing across the border. Canadians have high standards of living, and demand large quantities of manufactured goods. In addition to the local market, Canadian manufactures have tariff preferences in other parts of the British Commonwealth of Nations. This has led to the establishment of Canadian factories by many American manufacturers Mining is of much more importance than the occupational figures would seem to indicate Canada supplies most of the world's asbestos, nickel, and cobalt, and is an important producer of lead, zinc, silver, gold, and copper. Petroleum is almost lacking. Coal

Figure 216

PERCENTAGE OF GAINFULLY EMPLOYED IN PRINCIPAL CLASSES, CANADA—1931

Occupation	*Per Cent*
Agriculture	28 8
Forestry, Fishing, and Trapping	2.3
Mining and Quarrying	1.5
Manufacturing	11.3
Electric Light and Power	.8
Construction	5.2
Transport and Communication	6.8
Trade	8 9
Finance	.9
Service (Professional, Public, Domestic, etc.)	16 2
Clerical	6.1
Laborers (Not in agriculture, mining or logging)	11.1
Unspecified	.1
Total	100.0

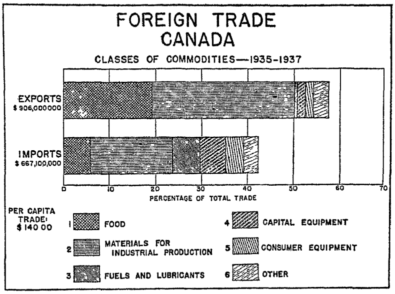


Figure 217. This and similar graphs occurring hereafter in this text are based on statistics in the *Statistical Yearbook of the League of Nations.*

is available in Nova Scotia and Alberta, but not near the large industrial areas which import large quantities from the fields in the United States.

Forestry, fishing, and trapping employ few people, but are dominant industries in most of the little-developed forest lands. Forest products, such as lumber, wood pulp and furs, total in value more than the produce of any Canadian industry except agriculture.

Foreign commerce is very important. Since Canada has but little variety in its products, it must import many goods to maintain its high standard of living. The large percentage of employed persons in the transport, communication, and trade classifications is largely a result of foreign commerce. The articles (Figs. 217 and 218) included in the exports reflect the dominant industries, while the imports include goods which cannot readily be produced in Canada because of climate or the small size of the market.

Figure 218

VALUE OF PRINCIPAL EXPORTS AND IMPORTS—DOMINION OF CANADA—1937

(millions of dollars)

EXPORTS		IMPORTS	
Article	*Value*	*Article*	*Value*
Wheat and flour	$148	Machinery	$ 89
Newsprint paper	126	Iron and steel	77
Lumber	63	Petroleum products	55
Copper	55	Coal	38
Nickel	55	Fruits and Vegetables	33
Wood pulp	41	Automobile parts	37
Meats	40	Raw cotton	19
Automobiles	23	Sugar	17
Whisky	20	Rubber	15
Others	417	Others	428
Total	$988	*Total*	$808

As might be expected, Canada's trade is predominantly with the United States and the United Kingdom, which both have similar economic and social systems and speak the same language. The United States is her nearest neighbor, and differences in resources and stage of development give a firm basis of trade with that country. Sixty per cent of Canada's imports come from the United States and 36 per cent of the exports go to that country. The United Kingdom requires Canadian foods and raw materials and is a source of manufactured goods. Eighteen per cent of the imports come from the mother country and 41 per cent of the exports go to that destination.

QUESTIONS FOR DISCUSSION

1. Summarize the evidence for the statement that "Canada is economically young."
2. Why is Canada the leading country in railroad tonnage carried per capita?
3. Examine the distribution of population as shown on the population map (Figure 214). Explain it

The National Economy of the United States

Population. The growth of the population of the United States has been rapid in the past but appears to be slowing up The greatest rate of increase in any decade occurred between 1800 and 1810 when the rate of increase was 36 4 per cent. The highest figure since the Civil War was an increase of 30 1 per cent in the decade between 1870 and 1880. The rate of increase in the census decade 1920-30 was but 16.1 per cent. This decline in the rate of increase has been due to a complex of factors, chief among which are the restriction on immigration, the decline in the birth rate, and the rise of the standard of living—a factor which has been largely the cause of the first two.

In the years following the World War, and before the slowing up of the rate of population increase had been discerned, some fear was felt that the country was soon to enter into a period of declining standard of living due to a rapidly growing population inhabiting a relatively fixed land area. It was thought, then, that there would be a population of 200,000,000

in the country by 1970. An analysis of recent trends indicates that perhaps the population of the nation may become relatively stable at a figure of approximately 150,000,000 by 1950.

Occupations. In 1820, approximately 72 per cent of the working people of the United States were engaged in agriculture. It was then a predominantly agricultural nation, as are many of the nations of the world at the present time. Russia, Bulgaria, and India still have more than 72 per cent of their workers directly engaged in agriculture. More than half of the American workers were engaged in agricultural pursuits down to the decade between 1870 and 1880. The proportion engaged in mechanical and manufacturing occupations exceeded that engaged in agriculture for the first time in 1920. At the time of the 1930 census, 28.6 per cent of the gainfully employed were engaged in the manufacturing and mechanical industries and but 22.5 per cent in agriculture. Both of these percentages were lower than those for the same occupational groups in 1920. The basic producers were, therefore, declining in importance as consumers of labor. The large increases between 1920 and 1930 were in such groups as trade, professional service, domestic and personal service, and clerical occupations. This is an index of the growing complexity of the American economic system. It is also an evidence of a high standard of living, as fewer workers are needed to produce materials and more are devoted to the distribution of goods and to the furnishing of services. Also there is less opportunity for the introduction of machinery into the distributive, personal service, and professional occupations than there is into agriculture or manufacturing.

Further evidence that the United States is now more predominantly industrial and commercial than agricultural is found in the distribution of its population between rural and urban areas. Incorporated places having more than twenty-five hundred people are considered urban in the United States. According to the most recent census 56.2 per cent of the population lived in such urban areas and 43.8 per cent in those classed as rural. That this was not all truly "agricultural" population is indicated by the fact that people living on farms were but 24.8 per cent of the total population of the country.

Changes in Agriculture. Prior to the depression which started in 1929 and brought with it considerable government regulation of agricultural production, there had been for some years an increase in the quantities of most farm products in spite of a decrease in the number of acres under cultivation and a decrease in the number of farms and farmers. This was apparently due not to any large increase in production per acre, but to the following trends:

1. Greater use of agricultural machinery and automobiles released land formerly required to feed or pasture farm draft animals and allowed it to be used for pasture or the production of feed for dairy cattle or swine.
2. Increased efficiency in feeding produced more meat or dairy products from the same amount of feed.
3. Shift from less productive to more productive crops (such as from wheat to corn, corn to cotton, or beef to dairy cattle)
4. A shift in the food habits of the American people away from meat and bread to dairy products and vegetables.

The demand for American agricultural products has also been diminished by decreased demand and lower prices in the foreign market. Lower foreign prices have not only decreased the value of the exports, but have in turn, as with most export commodities, reduced the price received by the farmer in the home market. Foreign demand for American farm products has lessened partly because of increasing attempts throughout the world to attain national self-sufficiency and partly because producing areas that were unproductive during the World War have come back into production. The situation discussed in the chapter on cotton (pages 188-190) is duplicated to a lesser extent for many other farm products.

About one-third of the land of the United States is capable of crop production but only 18 per cent is in crops Considering the recent trends in American agriculture, it may become advisable to further decrease the amount of land under crops. The United States imports wood pulp and animal products, such as leather and wool. With more land in forests and pasture, such imports might be eliminated, with fewer floods and duststorms as incidental benefits.

In the recent past the forests of the United States have been cut at a rate equal to four times the annual growth. This is still going on, but there is evidence of a change in trend. Not only have wood products become expensive enough that they make a profitable "crop" on poorer land, but the demand for land for agriculture is decreasing and much of it is being turned back to the forest. This, together with greater care in forestry methods and protection against fire and other enemies, promises to make an important contribution to the country's yield of wood. It is estimated that with proper care and reforestation the United States can in the future meet all its demands for woods, other than tropical cabinet woods, from within its borders. It still has greater forest reserves than any country except Russia.

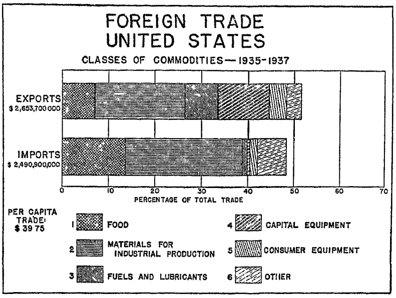


Figure 219. Compare with Figure 217 Do these graphs indicate that the United States is industrially more mature than Canada?

Power Resources. The United States leads all other countries in the production of coal, petroleum, natural gas, and hydroelectric power. In reserves for the future, coal supplies need cause no concern. Petroleum and natural gas supplies are more easily, although not immediately, exhaustible. Most of the remaining undeveloped water power is too far from present markets to be economically useful.

The United States stands far ahead of any other country in the use of mechanical power. Throughout its history it has had a small population in proportion to its vast area and resources In production labor has been the scarce element, thus there has been an extensive use of capital (mostly in the form of machinery) and a high standard of living. It has been estimated that half the world's mechanical

Figure 220

FOREIGN TRADE OF UNITED STATES: PRINCIPAL COMMODITIES

EXPORTS

Commodity	*1926-1930 Average* Amount (millions of dollars)	*1926-1930 Average* % of total	*1937* Amount (millions of dollars)	*1937* % of total
Machinery [1]	488.0	10.4	479.1	14.5
Petroleum and Products	524.4	11.2	376.3	11.4
Cotton, unmanufactured	765.7	16.3	368.7	11.2
Automobiles, Parts and Accessories	406.2	8.7	346.8	10.5
Iron and Steel-mill Products	170.7	3.6	299.9	9.1
Chemicals and Related Products	137.4	2.9	139.4	4.2
Tobacco, unmanufactured	144.5	3.1	134.5	4.1
Copper, including Ore and Manufactures	150.0	3.2	93.5	2.8
Fruits and Nuts	122.2	2.6	82.2	2.5
Coal and Coke	121.8	2.6	67.4	2.0
Wheat, including Flour	230.6	4.9	61.2	1.9
Cotton Manufactures	124.1	2.6	59.7	1.8
Sawmill Products	100.6	2.1	53.7	1.6
Iron and Steel, Advanced Manufactures	78.2	1.7	52.1	1.6
Packing-house Products	194.1	4.1	42.6	1.3
Total [2]	4,687.8	100.0	3,294.9	100.0

IMPORTS

Commodity	*1926-1930 Average* Amount (millions of dollars)	*1926-1930 Average* % of total	*1937* Amount (millions of dollars)	*1937* % of total
Rubber, Crude	294.4	7.3	247.5	8.2
Cane Sugar	207.3	5.1	166.2	5.5
Coffee	281.7	7.0	150.6	5.0
Paper and Manufactures	151.2	3.7	137.1	4.6
Paper, Base Stocks	114.5	2.8	117.9	3.9
Vegetable Oils	81.9	2.0	112.0	3.7
Silk, Raw	368.2	9.1	106.6	3.5
Tin (Bars, Blocks, Pigs)	88.9	2.2	104.3	3.5
Chemicals and Related Products	132.8	3.3	102.6	3.4
Wool and Mohair	78.8	2.0	96.4	3.2
Furs and Manufactures	114.8	2.8	86.2	2.9
Wine and Spirits	.4	[3]	72.7	2.4
Hides and Skins	118.0	2.9	71.1	2.4
Fruits and Nuts	84.9	2.1	67.3	2.2
Grains (Corn, Oats, Rye, Barley)	1.6	[3]	66.0	2.2
Total	4,033.5	100.0	3,012.5	100.0

1 Includes office appliances and printing machinery.
2 Total includes items not listed above.
3 Less than one-tenth of 1 per cent.

power derived from mineral fuels or falling water is developed in the United States. The United Kingdom develops but 15.5 per cent and Germany but 10.5 per cent.

The Metals. In an industrial age a sufficient supply of the principal metals is a necessity. This country is fortunate to have such a supply largely within its borders. It leads the world in the production of iron, copper, lead, and zinc. With the exception of lead, the reserves of each of these promise to be sufficient for the nation's needs for some time to come. It may, however, be forced to use lower grade iron ores in the not far distant future Only tin, bauxite, manganese, and some of the ferro-alloys are insufficient in quantity or too costly to mine in this country.

Foreign Trade. In total volume of foreign commerce the United States and Great Britain vie for first place. The fundamental nature of the trade of the two is different, however. Great Britain is a great middleman selling its skill and location in exchange for raw materials and food: Britain must trade to live. The United States, with its vast area, large resources, and great diversity of climate, is largely self-sufficient and imports to get those few raw materials and consumption goods which she cannot produce herself.

The amount of foreign trade per capita indicates roughly how dependent a country is on foreign countries. Formerly in normal times this country ranked sixteenth in this classification Extensive area and variety of resources and climate largely account for this. The United Kingdom, Germany, France, Belgium, and Switzerland all depend on foreign trade to furnish the bulk of the raw materials for their industries and much of their food. Countries like Cuba, British Malaya, Australia, the Argentine, and Denmark are producers of a single type of product (largely agricultural) which is consumed in the industrial nations Having developed very little in manufacturing, they must import their consumption goods. They must also export large quantities of goods to pay interest and principal on foreign investments within their borders.

Figure 221

PERCENTAGE DISTRIBUTION OF AMERICAN EXPORTS AND IMPORTS BY CONTINENTS—1900, 1937

Continent	*1900*		*1937*	
	Export	*Import*	*Export*	*Import*
North America				
Northern	7.0	4.7	15.5	13.2
Southern	6.5	10 6	9 6	9.2
South America	2.8	11 0	9 5	13 7
Europe	74 6	51.8	40.6	27 3
Asia	4 8	17 2	17.3	31 4
Oceania	2 9	3.4	3 0	2.2
Africa	1 4	1.3	4 5	3 0

The Nature of American Foreign Trade. The shift from agriculture to manufacturing noted earlier is clearly reflected in Fig. 222. The diversity of American import and export trade is also suggested by Fig. 220 which shows that the leading commodities do not belong exclusively to any one type. The exports include both highly manufactured goods—such as automobiles and machinery—and agricultural and mineral products—such as cotton, petroleum, and coal. The imports include tropical products like coffee, cane sugar, and rubber which are used for food or raw materials and which cannot, for climatic reasons, be produced in this country. The predominantly in-

Figure 222

FOREIGN TRADE OF THE UNITED STATES BY CLASSES OF MERCHANDISE

(expressed in percentages of value)

Classes of merchandise	EXPORTS				IMPORTS			
	Average 1866 to 1870	*1935*	*1936*	*1937*	*Average 1866 to 1870*	*1935*	*1936*	*1937*
Crude Materials	58	30	28	22	12	29	30	32
Crude Foodstuffs	9	3	2	3	13	16	14	14
Manufactured Foodstuffs	14	7	6	5	20	15	16	15
Semi-manufactures	4	16	16	21	14	20	20	21
Finished Manufactures	15	44	48	49	41	20	20	18

dustrial nature of the country is evidenced by the fact that the leading imports include few manufactured articles.

The Balance of Trade. The United States was for long a country with a so-called "favorable" balance of trade: that is, the value of its exports exceeded the value of its imports. Since the World War, however, the value of exports and imports has tended to be more nearly equal. This is due, in part, to the fact that the United States has become predominantly a creditor rather than a debtor nation, and other countries must send in goods to pay interest and principal on their indebtedness Perhaps falling exchanges and lower costs abroad have also helped to increase, relatively, American imports of foreign manufactures. They have certainly operated to decrease American exports of agricultural goods.

The Geographic Distribution. The geographic distribution of American foreign trade and the changes since 1900 are revealed in Fig. 221. That Europe has been the principal destination of the country's exports and source of its imports is simply an evidence of the general rule that trade tends to flow between regions of the most intensive commercial development. It is true that Europe has declined since 1900, both as to proportions of exports taken and imports supplied. This but reflects the fact that other parts of the world have developed.

Of great importance as customers and sources of imports are the relatively small populations of other portions of North America. Nearness and, in Canada, a common type of social and economic development would help to explain this Oceania has small part in the trade, because Australia and New Zealand are so far away, are tied more closely to Britain by political and sentimental ties, and are producing many goods similar to those which have been typical of the United States and of which it has such an abundance. Africa's share has changed but little.

There has been considerable increase in the percentage of trade which is carried on with South America and Asia. To a large extent this represents the reaching out by Americans for tropical and semitropical materials, such as coffee and forest products from South America and rubber from Asia. On the export side it represents the growing development of these regions and their consumption of American specialties, such as automobiles and machinery That Asia is nearly twice as important as South America in the foreign trade will come as a surprise to those who have been under the impression that this country's trade destinies lie to the southward. This is due, in large part, to American rubber imports and the great cotton export to, and silk import from, Japan.

Foreign Trade and American Foreign Policy. The resources of the United States permit it to become more self-sufficient than any other country except possibly the U.S S.R. American export trade, although very important to certain interests and regions, amounts to only one-tenth of the total American production. These facts together with the protective barriers of two great oceans explain why an "isolationist" policy is *possible* for the United States. The expensive and often unfortunate results of American intervention in foreign politics have encouraged the development of a strong isolationist sentiment, especially in the interior of the country.

Equally powerful influences encourage American intervention abroad. The United States is bound to other countries by the investments of its citizens as well as by their ancestry. Its export trade disposes of surpluses which could not be easily sold in domestic markets while its import trade provides essential raw materials, such as rubber and tin, which could not easily be replaced by domestic substitutes. In times of crisis abroad, the high prices offered for foodstuffs, steel, and munitions provide a temptation not easily resisted. Thus American foreign policy, because of these conflicting influences, has tended to fluctuate between isolation and intervention.

QUESTIONS FOR DISCUSSION

1. What evidence is there that the United States is becoming an economically "mature" nation?
2. Why is there such a small percentage of land in harvested crops in the United States? May it be expected to increase or decrease? Why?
3. Compare the foreign trade of the United States and Canada.
4. Look up the foreign commerce of the United States in the Commerce Yearbook or the Statesman's Yearbook Suggest an explanation for the importance of each of the leading nations in the trade of this country.

CHAPTER 39

THE EASTERN REGION

THE EASTERN region has unity, not so much because of physical features as because of its position and its history This region, stretching along the east coast of North America from Newfoundland to Baltimore and inland to a line roughly from Johnstown, Pennsylvania, to Ottawa (Fig 225) has been, throughout its history, the doorway to the continent. It contains most of the earliest regions of English and French settlement, and through it poured the peoples and the influences that were to conquer the continent. Age of settlement, maturity of economic system, leadership in the economic, cultural, and political life of two nations characterize this region. It is also the western terminus of the world's greatest ocean-trade route, that between eastern North America and northwestern Europe. Its commercial and industrial character is its greatest unifying force. The western boundary is a more or less arbitrary line, marking not a sharp change in characteristics, but a zone of transition toward interior conditions.

Environment and Occupations

Topography. Geologically, this region contains many old rocks which, after a complex geologic history, have developed into a mature, or postmature, topography. The altitudes are not great, but the country is often rugged, sometimes becoming mountainous as in northern and western Pennsylvania, the Catskills and Adirondacks of New York, and the Green and the White mountains in New England. Between the mountains are broad valleys; these are often fertile agricultural areas, highways of trade, or districts of intensive industrial development. The most important of these is the Hudson-Mohawk Valley system which acts as a natural route between the interior and the coast and has been so important in effecting the growth of New York (pages 274, 329). The only considerable areas of continuous lowland in the region are the portions of southern and eastern New Jersey, and Delaware, which lie in the Atlantic Coastal Plain. Other lowlands, such as the Lancaster Plain in Pennsylvania, are less extensive and appear as "islands" in a rougher country. The most recent crustal movement of importance has been downward, resulting in the slight "drowning" of many river valleys and forming an abundance of excellent harbors.

Climate. The climate is uniform in type, although varied in detail (Fig. 223). The cyclonic control is dominant in winter and less strong in summer. The modifying influence of the sea does not extend far inland because the prevailing wind is from the continent. Winters are, therefore, more severe and summers hotter away from the sea. Winters severe enough to bring water transport to a standstill for several months prevail in Quebec, but summers are warm. Temperature conditions vary from this to the condition in southern Pennsylvania, where winters are cold, but not usually severe, and summers are hot. Rainfall is ample throughout the region and is usually well distributed.

Agriculture. The rough topography, the mediocre or poor soils and the short growing season, together with relative accessibility to markets in the industrial and commercial areas, have put their stamp on the agriculture of the region. The predominant type is general farming, often combined, however, with some specialty such as dairying, truck gardening, poultry raising, orchards, or tobacco production, depending on the peculiarities of position, soil, and climate.

That the excellence of the local market only partly compensates for the disadvantages of the physical environment is shown by the tremendous quantities of food—even perishable foods, such as butter and eggs—which are shipped into the region from the Middle West and even from California.

Recreational Industries. These industries are widespread throughout the region, and there are resorts to appeal to all temperaments. Theaters, night clubs, and general sightseeing attract a large stream of vacationists to New York, Boston, Philadelphia, Montreal, and other large cities. Beach resorts offer salt-water bathing and some of the larger attempt to rival New York in other amusements Much of the

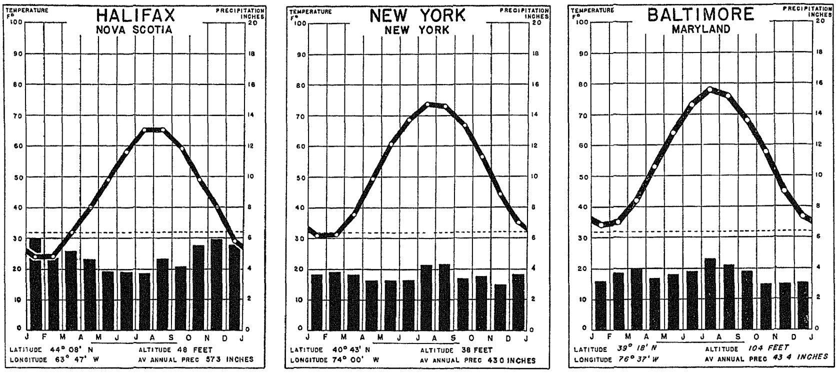


Figure 223. Compare these charts with the chart for Quebec (Fig 78) and those for Des Moines, Dodge City, and Bismarck (Fig 228). Why the differences?

region is elevated sufficiently to make the average summer temperatures 5° to 10° below those in the large cities, which are usually in the lowlands. In northern New England increased latitude supplements increased altitude in making pleasant summer weather. Within these cooler regions are both modern hotels and wild areas where hunting and camping can be enjoyed Finally, all of this region can be reached within a day's journey by more than 20,000,000 urban people, most of whom wish to spend their holidays in nonurban surroundings.

Mining. The region has only a few mineral industries, but they are of great importance. The great bituminous coal fields of the Appalachians lie to the westward, and only in Nova Scotia and New Brunswick are there small deposits of this resource within the boundaries of the region. Northeastern Pennsylvania has the most important anthracite field in the world and, from mines about Scranton, Wilkes-Barre, and Hazleton, sends coal for domestic heating purposes to all parts of the East.

Excellent cement-making material is found in large quantities near Allentown and Bethlehem in the Lehigh Valley in Pennsylvania and this fact, together with the tremendous market in near-by cities, has given rise to a district specializing in the manufacture of Portland cement. The fine marbles and granites of Vermont, as well as large quantities of less expensive building stone, widely available, make an important contribution to the construction industries of the region.

Lead, zinc, gold, and silver are mined in small quantities in the Canadian portions of the region. Thetford, southeast of Montreal, is the center of one

Figure 224

PERCENTAGE OF TOTAL EMPLOYED IN SELECTED OCCUPATIONAL CLASSES [1]

1930 [2]

Political unit	*Agric, forestry, fishing per cent*	*Manufacturing per cent*	*Mining per cent*	*Trade and transport per cent*
United States	22	29	2	20
Rhode Island	3	55	*	21
Connecticut	6	50	*	24
Massachusetts	4	46	*	26
New Hampshire	12	46	*	20
Maine	20	33	1	23
Vermont	28	28	2	20
New York	5	35	*	31
New Jersey	4	42	*	30
Pennsylvania	7	40	9	25
Delaware	18	35	*	24
Maryland	13	33	1	27
Ontario	24	22	1	19
Quebec	25	20	1	17
Nova Scotia	32	11	9	17
New Brunswick	39	11	1	17
Prince Edward Is.	61	5	*	11

* Less than 1 per cent

1 Fifteenth Census of the United States, 1930. Canadian Census, 1931.

2 Canadian figures are for 1931.

of the world's leading asbestos districts. Iron ores of high quality and considerable quantity are found on the south coast of Newfoundland.

The Supremacy of Manufacturing and Commerce. This region is largely industrial and commercial, although more so in the United States than in Canada. Figure 224 shows the importance of the various occupations as sources of employment in each state and province.

The manufactures of the region are highly diversified and include the following major types:

1. Processing of imports and exports at ports (oil refining, sugar refining, copper smelting, coffee roasting, assembling of automobiles, etc.)
2. Packing imports or exports into containers (bottling, canning, etc.).
3. Manufacture of articles involving highly specialized and skilled labor (watches, typewriters, tools)
4. Manufacture of articles which—because of style, labor supply, or perishability—are best produced near market (clothing, furniture, perishable goods).
5. Heavy industries (steel, glass, concrete), which are found mainly in eastern Pennsylvania.

Dense population and manufacturing industries give rise to a huge local commerce, which is supplemented by a heavy through traffic from the interior to the ports. An examination of a railroad map will show that the bulk of the major lines connect with the interior—the principal exception being the Boston-Washington route.

QUESTIONS FOR DISCUSSION

1. What is a "region"? What justification is there for the boundaries given to this region?
2. Review Huntington's theory of civilization and climate. How does it apply to this region?
3. Look up in an atlas the major railway routes from the interior. How many terminate at New York? Boston? Philadelphia? Baltimore? Halifax? Montreal? Portland?

Eastern Canada

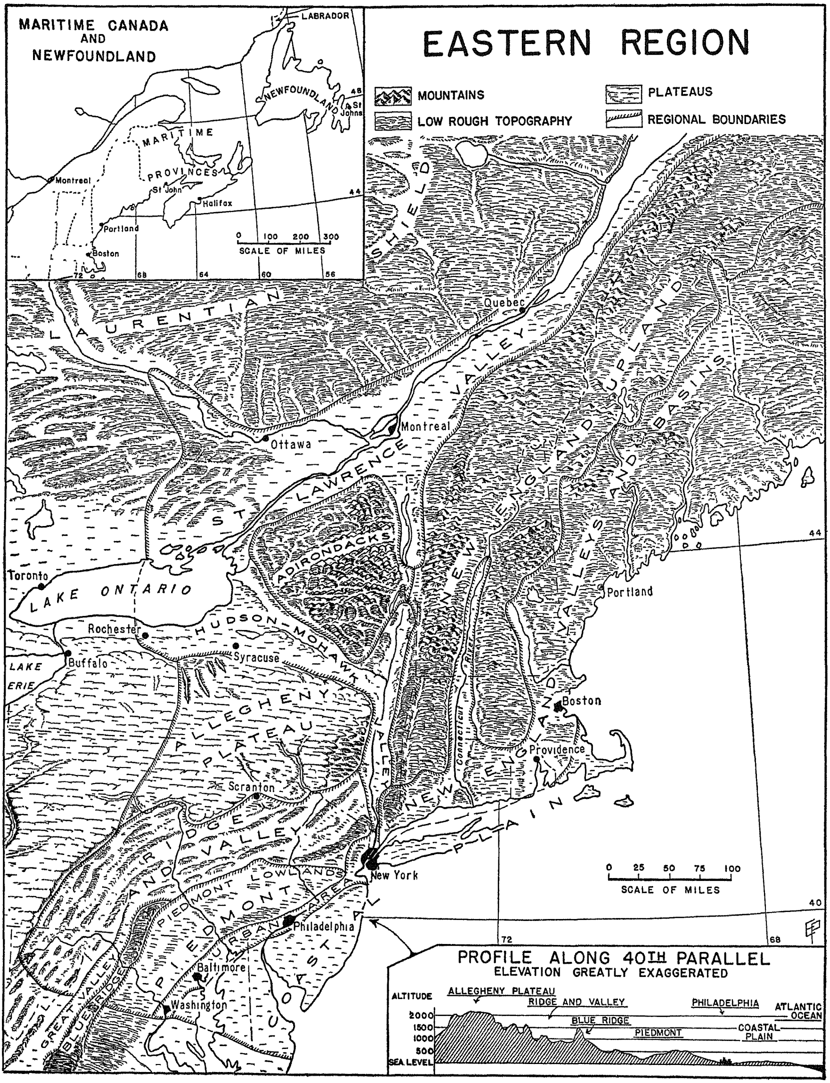
The St. Lawrence Valley. Eastern Canada contains two of Canada's four areas of relatively dense population. The valleys and coastal fringes of the Maritime Provinces are inhabited by a people predominantly British in origin, while the St. Lawrence Valley—from Gaspé to above Montreal—is French in language and culture. Here, in a long narrow valley with snowbound winters and mild summers, live a pious, hardworking, prolific people, who have used the limited resources with the thrift of the French peasant rather than with the openhandedness of the American pioneer. The homes and small farms of these people are to be seen as a continuous row for hundreds of miles along the southern shore of the St. Lawrence, once the only artery of trade. The farms are narrow, but often miles deep, for in early days each farmer needed an outlet to the river. Today, in the broader parts of the valley (especially south of a line from Montreal to Quebec) the settlements have extended back to the northern edge of the New England upland, but the houses and type of farming are often strikingly similar to those of the original settlements.

While the birth rate of other parts of North America declines, the French Canadians continue to have large families. The surplus population is pushing north into the infertile lands of the Laurentian Shield and south into northern New England and even into the New England manufacturing towns. "Ferme à vendre" is not an uncommon sign in northeastern Vermont, while throughout northern New England, French is often used along with English in the parochial schools. Many a farm abandoned by a New Englander has been made to provide an income which, though small, is sufficient for the frugal French Canadian.

Agriculture is primarily subsidiary to dairying. Aside from vegetables, fruits, and cereals raised for home consumption, the principal crops are hay, barley, mangels, and other fodder crops. The international boundary and distance cut off the valley from the great urban markets of New York and New England, hence dairy products are sold largely as cheese.

Montreal, located at the head of ocean navigation, is the metropolis of the area. Here the Ottawa River Valley and the Lake Champlain Valley meet the St. Lawrence, making Montreal a crossroads as well as the head of navigation. Half the trade of Canada passes through this port, and many of the goods stop in the vicinity for processing or manufacture. Thus, wheat is milled into flour and lumber is converted into wood pulp and paper, and imported raw materials are converted into textiles, shoes, refined sugar, or gasoline for the Canadian market. The rather abrupt termination of the Laurentian Shield to the north of the valley has created numerous falls in the many short tributaries of the St. Lawrence and has provided huge water power resources which, with abundant labor, have given manufacturing a tremendous impetus. The Saguenay, navigable tributary of the lower St. Lawrence, is a highway over which imported bauxite is carried far inland to the tremendous water power at Chicoutimi.

Downstream from Quebec, settlements, especially



EASTERN REGION
MOUNTAINS
LOW ROUGH TOPOGRAPHY
PLATEAUS
REGIONAL BOUNDARIES
MARITIME CANADA AND NEWFOUNDLAND
LABRADOR
NEWFOUNDLAND
St Johns
MARITIME PROVINCES
Montreal
St John
Halifax
Portland
Boston
SCALE OF MILES
LAURENTIAN SHIELD
Quebec
Montreal
Ottawa
ST LAWRENCE VALLEY
ADIRONDACKS
NEW ENGLAND UPLAND
VALLEYS AND BASINS
Toronto
LAKE ONTARIO
Rochester
Buffalo
LAKE ERIE
Syracuse
HUDSON-MOHAWK
ALLEGHENY PLATEAU
Scranton
RIDGE AND VALLEY
Portland
Boston
Providence
Connecticut River
NEW ENGLAND
PIEDMONT LOWLANDS
New York
PIEDMONT
URBAN AREA
Philadelphia
Baltimore
Washington
GREAT VALLEY
BLUE RIDGE
COASTAL PLAIN
SCALE OF MILES
PROFILE ALONG 40TH PARALLEL
ELEVATION GREATLY EXAGGERATED
ALTITUDE
ALLEGHENY PLATEAU
RIDGE AND VALLEY
BLUE RIDGE
PIEDMONT
PHILADELPHIA
COASTAL PLAIN
ATLANTIC OCEAN
2000
1500
1000
500
SEA LEVEL

Figure 225.

on the north shore, thin out, and fishing, hunting, and some lumbering almost displace agriculture in the scattered villages. In Newfoundland, also, these industries are dominant, and fishing on the near-by Grand Banks is especially important. The iron ore reserves of Conception Bay on the southeastern coast of Newfoundland are among the largest in the world and, because they lie on tidewater within five hundred miles of the coal fields of Nova Scotia, promise to become of increasing importance. Ore from this deposit is now being used in the steel industry about Sydney, Nova Scotia, in other parts of Canada, and even in Pennsylvania and in Europe.

The Maritime Provinces. Physiographically, Nova Scotia, New Brunswick, and Prince Edward Island are a continuation of adjacent New England, but differences in government and position have altered their development. Several excellent harbors, including St. John and Halifax, have developed largely as winter outlets for Canadian trade, but during the warmer months the ships penetrate to the head of navigation at Montreal. Nova Scotia has bituminous coal at tidewater on Cape Breton Island, but this coal cannot compete in inland Canadian markets with the nearer Pennsylvania coal. It is used locally for domestic purposes and in a small iron industry, in conjunction with Newfoundland ores. Except for the apple center in the sheltered Annapolis-Cornwallis Valley, the industries are the same as those in adjacent areas: potato raising, dairying, lumbering, fishing, fur farming, and the summer vacation trade.

New England

The New England Upland. This picturesque rugged region has been revolutionized by transportation. Rapid transit from the Middle West made cereal farming in its valleys unprofitable. Better local transport made it possible to develop a dairy business which was a partial substitute for the lumbering and farming of the early nineteenth century. Good transportation has also encouraged the development of a tourist business and, in this, New England has equaled other resort areas in advertising its facilities. Aside from these almost universal activities there are many specialized industries located in towns and cities throughout the uplands. Traditional skill and accumulated capital rather than local resources account for most of these. They include insurance companies, printing establishments, machine shops, and manufactures of hardware and many small contrivances—such as clothespins, doorknobs, and corkscrews.

The New England Valleys and Basins. More than three-quarters of the people of New England live on the coastal lowlands and basins and in the Connecticut Valley. Here are lowlands with rolling to level topography, covered with a thin layer of alluvial or glacial soil. Except in a few fertile areas farmers find it difficult to compete with the agriculturally more-favored South and Middle West, and the people have turned to manufacturing and the sea for a livelihood.

Manufacturing. The rise of industry in New England cannot be understood if this section is considered only in terms of present-day knowledge of the entire United States. It has no coal, almost no metallic raw materials, an inadequate supply of water power, and is only moderately well situated with regard to market. The principal advantages, today, lie in the nature of the people and the tradition of skill and organization in manufacturing that has grown up there. Perhaps the climate is conducive to the energy necessary to manufacturing. History is, however, one of the important keys to the explanation.

In colonial days, New Englanders found that they had little to export. The soil, topography, and climate were not conducive to great agricultural surpluses The result was to force a relative self-sufficiency which turned the people toward manufacturing to meet their own needs. They supplied many of their wants by household handicrafts and used small waterfalls to provide power for grinding grain, sawing wood, and fulling cloth.

Fisheries and Trade. The search for goods to export led to exploitation of the fisheries. The shallows off the coast of Massachusetts and Maine and the Grand Banks off Newfoundland were feeding grounds of the world's finest commercial types of fish. They were caught in tremendous quantities by New England fishermen, and the foundation was laid for New England's era of supremacy on the sea. Old England had fisheries of her own, and New England fishermen were forced to turn to the Catholic countries of the Mediterranean and the plantations of the West Indies for a market Their ships brought back sugar, rum, cotton, and other goods and furnished raw materials, the value of which they were quick to see. This trade also opened markets for timber and, later, products of the early manufacturing industries. Following the Industrial Revolution in England, profits made in fishing, whaling, and trade were used

to build factories. With the passing of sail and wooden ships, New Englanders began to abandon the sea; nevertheless the fisheries which started the trade are still the most valuable in the United States, and the impetus that they gave to manufacturing has determined the predominant activity of the people of this section.

The Rise and Decline of the Textile Industry. The early application of the factory system and of power to manufacturing was largely in the textile field, since clothing was the most common article of consumption not directly provided by agriculture or forestry. To a people among whom hand manufacture of cloth was common, the advantages of the invention of power spinning and weaving were obvious, and they adopted them quickly. The invention of the cotton gin about the same time made that staple the cheapest textile material, and the already well-established trade with the South soon brought cotton to New England mills in large quantities.

Before the development of hydroelectric power, mills were placed along the streams where water power could be utilized directly. Soon industries outgrew local power resources and coal was imported in large amounts from Pennsylvania by rail and water. Thus arose the cotton-textile industry which was the economic backbone of this region for more than a century.

In more recent years, however, this industry has migrated southward toward cheaper labor, cheaper land, cheaper power, and lower taxes. In 1932-33, Southern mills consumed more than five times as much raw cotton as those of New England. Only in the woolen goods and more complicated phases of the cotton textile industry has New England been able to hold its own.

Machinery and Other Industries. New England metal products have long been famous. Beginning with the colonial period, many farmers used their spare time during the long winter to fashion tools and other metal devices out of secondhand metal. These were sold widely throughout the colonies by shrewd Yankee peddlers. Later the growth of textile and other industries led to a demand for machinery The mechanical skill of the early metal workers led to new inventions and provided the ability to reproduce those made elsewhere. The mechanical and intellectual ability of its people, fostered by tradition and universal education, has long been the principal advantage of New England in industrial as well as other fields.

Today manufacturing industries include representatives of both historic staples and more diverse developments in lighter products. Old basic industries, such as boots and shoes and textiles, together contribute about one-third of the value of all manufactures, and the lighter products of high mechanical skill, such as machinery, tools, hardware, firearms, electrical goods, and watches and clocks, represent a slightly larger proportion. The trend away from the historic staples, as in the cotton industry, is likely to continue. The boot and shoe industry, likewise, is losing ground to competitors in the Middle West who are nearer the newer markets and have lower costs for power and raw material.

The characteristic product in New England, today, is one of high value in proportion to its bulk, so that it can be cheaply shipped to a distant market; one that requires little power and raw material, because both must, in most cases, be imported, and one that requires skill of organization and workmanship. New England manufacturing has grown in part because of the region's poverty in natural resources and finds its principal basis, today, in the advantage of an early start and in human resources.

The Distribution of Manufactures. In New England, as elsewhere, like manufactures tend to be produced in one neighborhood even if not so located by raw materials or market. In New England, where skill is so important, the advantage of starting a new factory where specialized labor is available is obvious. Usually towns affiliated with one industry are in the same river valley because of the ease of communication before the coming of the railroad and because of the logical expansion of activities along the topographic lines of least resistance.

Thus, the brass industry is strung along the Naugatuck Valley in Connecticut from Torrington, through Waterbury and Naugatuck to Bridgeport. The Merrimack in New Hampshire and Massachusetts is lined with textile towns from Concord, New Hampshire, to Lawrence, as are the Blackstone and Quinebaug valleys in Massachusetts and Rhode Island. The Connecticut Valley from Greenfield, Massachusetts, to Middletown, Connecticut, has a variety of specialties including textiles in the northern part (Northampton, Holyoke, Chicopee), munitions, machine-shop products, and electrical goods (Springfield and Hartford), and paper (Holyoke). Along the coast from Stamford, Connecticut, to Boston are a string of manufacturing cities (including South Norwalk, Bridgeport, New Haven, New London, and Providence) which make a variety of metal goods ranging from safety pins to ships. New Bedford and Fall River,

once booming textile centers, have turned to the manufacture of diverse specialties.

Agricultural Specialties. Agriculture in New England is generally subsidiary to the city—hence, truck and dairy farming are predominant. There are, however, a few areas of superior soil which produce important specialized crops. For example, the continental glacier deposited a large area of loose-textured, fertile sandy loam in a topographic pocket in Aroostook County, in northern Maine, where potatoes are readily grown for market and for seed, and—a special type—for starch manufacture. Extreme eastern Maine has an important canned blueberry industry based on an area of acid soil, which especially suits the blueberry. In southern Maine, an area of clay soil and cool summers produces excellent sweet corn for canning. Lastly, the fine alluvial soils of the Connecticut River Valley are rich enough for tobacco. Much of the product is the "Sumatra" type of cigar wrapper, which is grown at great expense under a protective covering of cheesecloth, but brings five to ten times the price of ordinary tobacco.

QUESTIONS FOR DISCUSSION

1. It has been said that the Maritime Provinces, Newfoundland, and Quebec "belong with New England" What benefits might New England receive if they were included in the United States? Would it be a help or a handicap to those provinces? Why? How might it affect Canada?
2. Examine the advertisements in a popular magazine (such as the *Saturday Evening Post*) Which products advertised originate in New England? What is a probable explanation for the place of origin of each?
3. Lowell, Massachusetts, has declined in population because of the southward migration of the cotton-textile industry. What practical measures might the Lowell Chamber of Commerce advocate to prevent further declines?

The Middle Atlantic States

The Hudson-Mohawk Valley. The importance of this valley in the growth of the New York metropolitan area has already been discussed (pages 274-275). Not only is it a highway, barge, and rail route, but along it is a string of manufacturing cities, each specializing in a few types of goods and each benefiting from location on the major route from the Atlantic seaboard to the interior plains. A few cities will illustrate the variety of products: Rochester—optical goods, flour, men's clothing; Syracuse—salt and chemicals; Schenectady—electrical equipment; Utica and Cohoes—knit goods; Troy—shirts and collars. It can be seen that these goods, like those of New England, require skill rather than bulky raw materials. The agriculture of this valley, with a few exceptions, also resembles that of southern New England.

New York is the terminus of the busy Hudson-Mohawk outlet. In addition to its well-known functions as a port, amusement center, and financial center, it is an important manufacturing city. Its 7,000,000 people, in themselves, provide a huge local market for a variety of goods. In addition it is known for goods that contain a style element This type of manufacture arose when much of the fine clothing, furniture, and other similar goods for the American market were imported from Europe through this port. Merchants from interior cities came to New York to select from imports and gradually, as American goods improved, to buy New York products as well. The availability of cheap immigrant labor was also especially important in the clothing industry. The publishing industry is another major New York interest, and is located there because of the intellectual leadership of the city. Most of the printing, however, is done in small cities within a few hours' journey of the publishing offices.

The Appalachians of the Middle Atlantic States. The physical regions of the Middle Atlantic States are largely controlled by the complexities of the Appalachian system. With the aid of Fig. 225 these regions may be summarized as follows, proceeding from east to west:

The Piedmont. This is a predominantly rolling region, largely underlain by metamorphosed rocks, which extends from the Fall Line (page 50) on the east to the Blue Ridge on the west. Soils on the higher ground are largely residual clays and clay loams. This factor, together with the large urban population at hand, results in an agriculture devoted largely to dairying and poultry raising. In this region there are several "islands" of sedimentary rocks and, consequently, different soils. The limestone soils about Lancaster, Pennsylvania, have been utilized for an advanced agriculture involving tobacco, wheat, truck crops, potatoes, dairying, and the raising of beef cattle. The Triassic Lowland, an area of reddish sandstones and shales in the western and northern part of the Piedmont, has sandy soils and is devoted to general farming, again with dairying and truck as specialties. Numerous small cities scattered throughout the whole region, because of excellent transportation and their position within the influence

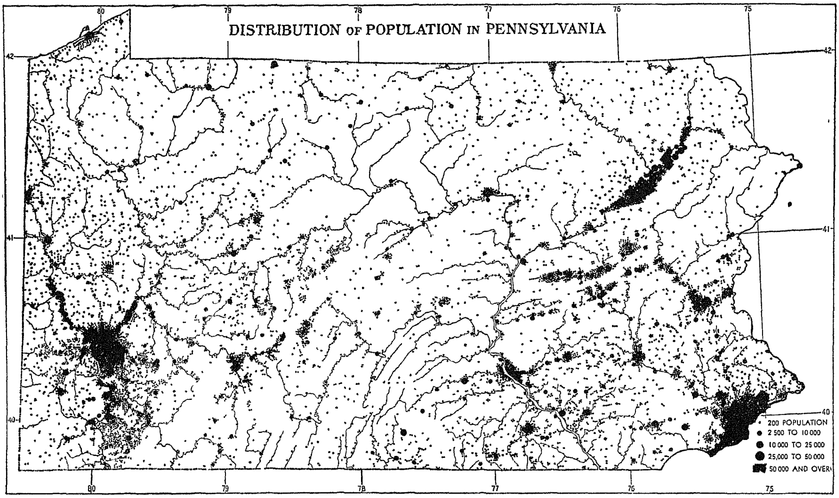


Figure 226. How can you identify the boundaries of the physical regions on this map? What factors other than relief features are needed to account for the distribution of Pennsylvania's population? (Courtesy of the *Geographical Review* (July, 1927), published by the American Geographical Society)

of the great urban centers to the eastward and the resources to the west and north, manufacture a variety of metal goods, textiles, housefurnishings, and clothing.

The Blue Ridge. West of the Piedmont is a narrow mountain zone which is a continuation of the Blue Ridge, so prominent to the southward. Here, however, this ridge of ancient igneous rocks is neither high nor continuous throughout its length, being represented only by small isolated remnants between the Susquehanna and the Delaware.

The Great Valley. This broad valley is the result of the erosion of a belt of limestone inclosed between harder rocks on either side. It is flat to gently rolling and has, generally, excellent soil which is utilized for general farming with an emphasis on grain and dairying. Many small deposits of limonite iron ores and easy access to both anthracite and bituminous coal gave rise to an early iron and steel industry which is now especially important in the cities of Easton, Bethlehem, Harrisburg, and Lebanon. The industry soon outgrew this local ore supply, however, and now uses ore from the West and overseas, supplemented by large supplies of iron and steel scrap obtained from near-by industrial centers. In the northern part of the valley, about Allentown and Bethlehem, there are large deposits of "cement rock," a limestone high in alumina content which has been the raw-material basis for a great cement industry supplying the large markets of the East.

The Ridge and Valley Section. To the westward and northward of the Great Valley, the complex folds of the Appalachian system have resulted in a series of alternate ridges and valleys. The ridges are continuous enough to isolate the valleys between, and, except where the main streams have furnished means of access by cutting across these ridges, the valleys are devoted largely to general farming and are sparsely populated. In the northeastern part of Pennsylvania, the folding which gave this section its topography compressed the local coal measures and created the world's greatest anthracite field. This coal is used to supply part of the domestic heating needs of the large population in the Northeast, the Middle West, and adjacent Canada. In addition to the coal-mining activities about such cities as Scranton, Wilkes-Barre, and Pottsville, there are numerous clothing and textile industries based on the abundant cheap labor supplied by the women and children of the miners' families.

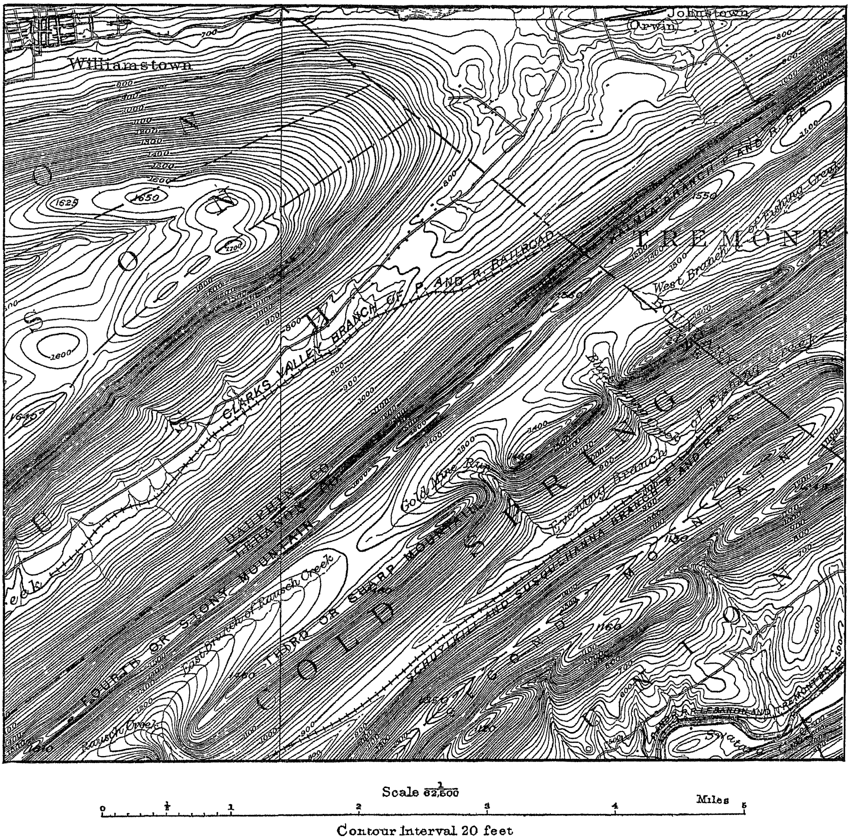


Figure 227. Part of the Ridge and Valley Section of Pennsylvania Why are there so many railroads in such a mountainous area? (From Lykens quadrangle, U. S. Geological Survey)

The Allegheny Plateau. This plateau, underlain by nearly horizontal strata of predominantly sedimentary rocks, lies to the west and north of the Ridge and Valley section Its eastern edge is a relatively abrupt escarpment (called the "Allegheny Front"), which has always constituted one of the most important barriers to penetration of the interior. From this Allegheny Front, the plateau slopes off gradually westward toward the Mississippi Basin. It is highly dissected by its numerous streams and, except in places along main streams where its coal resources, combined with easy transportation, have given rise to manufacturing, it is too rugged to be used intensively for any purpose and is sparsely populated. In the Poconos in northeastern Pennsylvania and the Catskills in New York, excellent mountain scenery and nearness to large urban areas have led to extensive recreational and resort development.

The New York to Baltimore Urban Area. From New York to Baltimore, there extends an almost unbroken line of cities which constitutes one of the major commercial-industrial areas of the world. Long freight trains run almost continuously between these cities, and large numbers of passenger trains, trucks, busses, and airplanes supplement this service. This great route uses the level land of the Coastal Plain as far as Trenton and then follows the Fall Line border between the Piedmont and the Coastal Plain.

Manufacturing. Early development of manufacturing was largely due, as in New England, to the skills and demands of the people, though here there was more to work with: water power, available from the earliest times and long since eclipsed by coal from the great fields of Pennsylvania, local iron ore, much more plentiful than in New England and, while not used now in large quantities, still mined in New York and Pennsylvania; and better and more abundant agricultural land providing raw materials to a larger local market.

Of utmost importance, the stretch of coast from New York to Baltimore is the terminus of the greatest routes between the Atlantic and the interior: the great ports of New York, Philadelphia, and Baltimore, each connected with all parts of the world by sea and with all parts of the United States by railroad. New England, hemmed in by her mountains, had easy access to but a small area, while this section could easily reach back into the far interior —from New York by the Hudson-Mohawk route, from Philadelphia by the Susquehanna, and from Baltimore by the valley of the Potomac.

Types of Industries. There is almost no limit to the variety of industry which is carried on here. Textile industries with a basis similar to that in New England are found in the Philadelphia district. The manufacture of clothing in New York City and Philadelphia is, however, based more largely on nearness to urban markets and fashion centers. Formerly the availability of cheap immigrant labor was also important. The hardware and machinery industries are as common here as in New England, for the quality of the labor and the age of the development are fully as favorable. All products of the iron and steel industry, from the pig iron, girders, locomotives, rails, sheets, and tubes, to the finest bit of machinery, are represented somewhere in the region. The port districts have built up great refining industries based on the import of foreign raw materials and near-by coal. All principal ports have sugar and oil refineries and the New York district refines lead, zinc, and copper in large quantities.

Because of the world market made available by foreign commerce, many industries which originated elsewhere have moved into this section to manufacture for export. This is especially true of the automobile and electrical-goods plants which have been established in the New York and Philadelphia areas in recent years.

Markets resulting from shipping activity, availability of fuel and raw material, and the skill of the laboring population have combined to give rise to the most important shipbuilding industry in North America. Great commercial yards have sprung up at Philadelphia and elsewhere on the lower Delaware, at Baltimore, and at various points within the Port of New York. In addition, both Philadelphia and New York have naval-construction yards which are among the most important in the United States.

The Coastal Plain. This generally flat, infertile, sandy, monotonous area would probably have been largely undeveloped were it not for its position next to the New York-Baltimore urban area. Even with this position most of it is a wilderness of scrub oak and stunted pine and only its best or most accessible parts have developed into suburban residential areas or satellite manufacturing districts. Beyond these, on the inner margin of the plain, is a strip where the soil is somewhat above the average and where, by heavy fertilization, high yields of vegetables and fruit can be obtained. These products are shipped fresh to the urban centers in as large quantities as the demand justifies, and the surplus is canned.

The coastward margin of the plain has developed into an almost continuous line of resorts usually built on an offshore barrier beach, separated from the mainland by a lagoon which makes an excellent harbor for small craft. The sandy, gently sloping beaches and cooling sea breezes attract millions of visitors from near-by cities. Atlantic City is the largest and most famous of these resorts. It is a veritable metropolis of amusement and is connected with New York and Philadelphia by frequent rail and bus services and excellent roads for the private motor car.

QUESTIONS FOR DISCUSSION

1. Most of Pennsylvania and New Jersey and all of Delaware and Maryland are unglaciated. What economic significance has this had?
2. Why is a larger proportion of vegetables sent to canneries in Maryland than in central New Jersey?
3. Account for the location of each manufacturing area in the Eastern Region.

CHAPTER 40

THE HEART OF NORTH AMERICA

THE EASTERN region was described as an area of predominantly rugged topography with a few "islands" of low, flat land; the Heart of North America is essentially a great rolling plain with a few "islands" of rougher topography. Indeed, the great plain which occupies the heart of the continent between the Appalachians and the Rockies extends far beyond the Heart of North America and includes parts of the South, the West, and subarctic North America. On this plain, and spilling over its edge to some extent on the east, lies one of the richest industrial and agricultural regions in the world. Its boundary on the east is an indefinite zone of transition, but its other boundaries are more specific. The southern limit is set by a line south of which the growing season is long enough (approximately two hundred days) for a subtropical crop like cotton; the western boundary, by the amount of rainfall sufficient to grow wheat with moderate safety (approximately nineteen inches per year in Kansas and eleven inches in Alberta); and the northern boundary, by a growing season too short for most crops (less than ninety days), and the cold, sour soils of the northern coniferous forest.

The great plain in which it lies is the greatest single unifying factor in the Heart of North America, but there are others. It has a continental climate throughout, with the hot summers and cold to severe winters, and the summer maximum of rainfall characteristic of such climates. Its position far from the sea, which gives this region its continental climate, also causes other problems. In spite of the tremendous influence of the Great Lakes and the lesser importance of the Mississippi waterways, this region owes its present character largely to the way in which it has solved the problem of land transport by the use of the railroad. Long rail hauls and high freight rates are common problems in most of the region.

Just as the East found unity in its long history, so the heart of the continent has a unity in its relative youth. Its growth came in the "national" days of the United States and Canada and is not strongly influenced by colonial history. It is young economically, as is indicated by the predominance of extractive industries, although approaching maturity has brought industrialization to its eastern portions. Its youth has made it a field for experimentation. There is probably no form of economic or political organization known to man that has not been tried, or at least advocated, somewhere between the Appalachians and the Rockies.

Resources and Occupations

Forest Resources. The more humid parts of this region were once covered with a great stand of hardwood or mixed hardwood-softwood forest. On the better soils this has long since been removed to make way for cultivation. There still remain, however, important forest resources in areas with poor soils and growing seasons too short for profitable agriculture. This is especially true in the Great Lakes area where, on both sides of the international boundary, forestry is the main occupation of large districts.

Agriculture. The character of the region is very largely the product of great agricultural development, for which it has more advantages than any other region of like size in the world. Its climate is suited to many crops and to the development of the highest type of human energy; its topography is generally level or rolling and its soils are predominantly rich. Although located in the interior, the Heart of North America is favorably situated with respect to the whole American and Canadian market—one of high standards of consumption—and not unfavorably situated for foreign export. In addition, this region has been settled in an economy where labor was scarce and land and capital were relatively abundant. This, together with the level topography and loam soils which are so suitable to the use of machinery, has resulted in a development of commercial, machine agriculture which has raised the standard of living of the farmer to greater heights than prevail in any other region of comparable size.

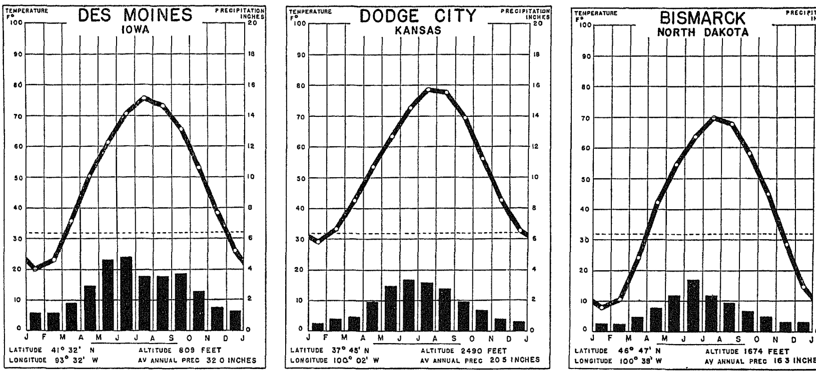


Figure 228. Which agricultural region does each station represent?

Mineral Development. The Heart of North America is not only one of the world's richest agricultural regions, but it also has tremendous mineral wealth. This has served as part of the basis for growing industrial development in the region and has furnished the tools, machinery, and power by means of which this has become the greatest area of machine farming in the world.

Coal. The two main coal fields of the United States lie within this region. The Appalachian field, with its thick seams of high-quality bituminous lying close to the surface, stretches along the eastern edge of the region in Pennsylvania, Ohio, West Virginia, Kentucky, and Tennessee. Nearly three-fourths of the nation's coal is supplied by that portion of the Appalachian field located within the region. Much of the coal from the eastern part of this field moves into the Eastern Region. Large quantities also move westward by way of the Great Lakes and supply most of the fuel for the manufactures of such lake cities as Cleveland, Detroit, and Chicago. The Illinois-Indiana field produces slightly less than one-fifth of the nation's total. The coal is not so high in quality as that in the Appalachian field, but it is the principal source of coal for the interior South and for Indiana, Illinois, and Missouri.

Petroleum and Natural Gas. The Mid-continent oil field lies on the southwestern margin of the Heart of North America and extends beyond it into Texas The oil is of excellent quality and yields high percentages of gasoline, kerosene, and lubricating oils. This is also the greatest natural-gas field on the continent. Much of its product is marketed as natural-gas gasoline.

The Appalachian oil field also lies within this region. Its production is small, but is of great significance because of the high-grade lubricants derived from it. Other small oil fields are found in southeastern Illinois and southwestern Indiana, in northern Indiana and Ohio, and in Michigan. The gas from all of these fields is important to the adjacent industrial areas both as an industrial fuel and for domestic use

Iron. Around the western end of Lake Superior lie the great hematite deposits which supply the bulk of the iron ore mined in North America Most of the best ore lies less than 1000 feet below the surface. Many of the deposits are faulted and folded and must be mined by underground methods. However, in the Mesabi and adjacent ranges of Minnesota, large quantities of ore are covered only by a thin layer of loose glacial drift and are mined by steam shovels. These deposits lie within 60 miles of the lake, and the ore is transported cheaply by rail and steamers to lower lake ports such as Chicago, Gary, Detroit, and Cleveland for smelting with coal from the Appalachian or Illinois coal fields.

Nonferrous Metals. The Heart of North America is also rich in a variety of metals other than iron. Copper is produced in considerable quantities in the upper peninsula of Michigan, in southeastern Tennessee, and in the Sudbury district of Ontario. This latter district has a variety of resources. In or near it are produced nickel, copper, gold, silver, platinum,

and cobalt. The world's most important lead district is in southeastern Missouri. The Tristate zinc district (Missouri, Kansas, Oklahoma) is the most important source of that metal, which is also produced in southwestern Wisconsin.

Transportation. The general levelness of the Heart of North America has permitted overland transport considerable freedom in selecting routes. In no other part of the country are roads and railroad lines so straight, in no other region do the main routes spread over such a large proportion of the country. Unlike New England, where main routes often follow major valleys, there are here no large isolated districts between the main routes except in some rugged areas on the borders of the region.

The Great Lakes are the greatest barrier to overland routes; in fact the concentration of these routes at Chicago is largely due to the necessity of going south of Lake Michigan. However, the lake barrier has been advantageous, for it has aided in the development of the world's greatest inland waterway, and has made the lake-shore cities ideal industrial sites. Other major railway centers, such as St. Louis, Omaha, Kansas City, Pittsburgh, and Cincinnati, represent junctions with water routes. Although the river routes now carry but a minor part of the traffic of these centers, these cities have an important and probably permanent vested interest as junctions.

Industrial Development. The people who settled this region were vigorous and mechanically skilled, and had high standards of consumption. It is not surprising that, in a region so richly endowed with resources and markets, industrial development has kept pace with agriculture. To some extent, indeed, the great agricultural activity has furnished both the raw materials and markets responsible for the industrial growth.

Manufacturing is, however, by no means evenly distributed throughout the region. It is generally most important in the east and least important in the west, southwest, and northwest. The greater industrialization of the east may be due to longer settlement and the consequent maturity of its economic life, but it is improbable that the area west of the Corn Belt will in the future become important in manufacturing. It has a small population, due to low rainfall (and therefore a small local market) and is distant from the markets of the East and Europe. In addition, it has poorer resources and does not have the life-giving, low-cost transportation which is furnished by the Great Lakes.

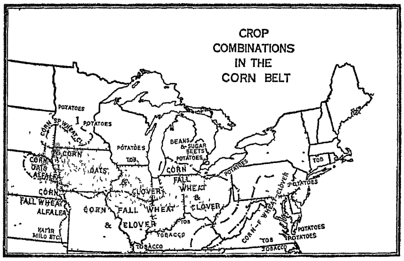


Figure 229 Dots represent corn production Crop rotation is an essential part of much of the agriculture of the Heart of North America. (Courtesy of U. S D A.)

The "youth" of this great region has not resulted in economic immaturity. Its rich soil, excellent climate, and level topography have combined with abundant supplies of mineral raw materials and fuels, fine transportation, growing markets, and a vigorous population to give it a balanced development in agriculture, manufacturing, and commerce which makes it one of the world's most favored regions.

QUESTIONS FOR DISCUSSION

1. Review the material on soils on pages 97, 112, 113-114, and 115. What are the characteristics of a chernozem, gray-brown podzolic soil, prairie soil, podzol? Where is each found in this region?
2. Why are the Great Lakes so much more important than the Mississippi River as an inland waterway?
3. How do the mineral resources of the Eastern Region compare with those of this region? To how great an extent do you think the differences have differentiated industrial development?

Agricultural Regions

The Corn Belt. Midwestern agriculture reaches its highest form in the Corn Belt. Here, on farms averaging 120 to 160 acres in size, the farmer usually raises corn, wheat, oats, and alfalfa in rotation. He also raises and fattens cattle and swine; and, in addition, often provides all, or a considerable portion, of the vegetables, fruit, and milk used by his family. Often he procures a steady cash income from the sale of his surplus cream and eggs to local stores and creameries or cream stations The feeding of stock allows him to market most of his crops as meat and to provide manure for his fields The system of rotation employed further contributes to the conservation of the soil. Thus, his risk is diversified, his labor, machinery, and draft animals are employed throughout most of

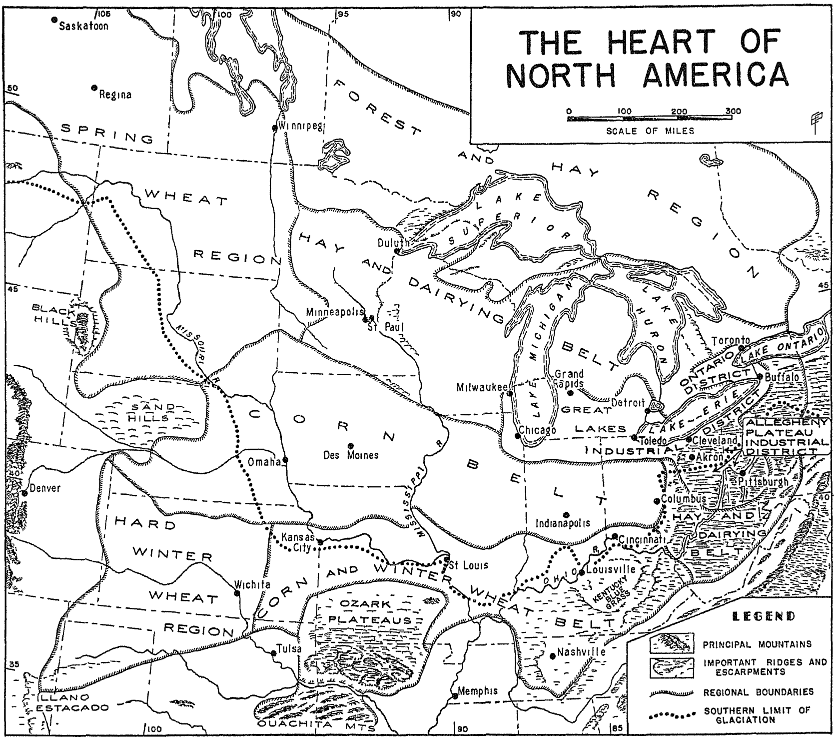


Figure 230.

the year and his agriculture attains a considerable degree of stability.

The Corn Belt was not made for the man who likes scenic grandeur. The area is generally so flat or gently rolling that the fields and roads were laid out like a checkerboard. Only near larger streams are valleys deep enough to produce much relief. Well-built houses, equipped with telephones, garages, and often with electricity and running water, and large barns are the only striking features of the skyline.

The prosperity of the Corn Belt farmer has encouraged the growth of prosperous market-towns and moderate-sized cities. Corn Belt farmers demand education for their children, entertainment for their families, and a variety of goods far above the bare necessities of life. The towns supply these needs while the cities in the area manufacture many of the goods distributed through mail-order houses or local stores.

The greatest industrial development is in the eastern half of the Corn Belt. Every city there handles and processes agricultural products, many supply such local farm needs as overalls, hardware, and agricultural machinery—some specializing in simple parts which are often assembled elsewhere. For example, Peoria, Illinois (population: 105,000), manufactures agricultural machinery, washing machines, oil burners, feeds, and corn products. Muncie, Indiana (49,700), produces automobile and electrical parts, glass jars, and steel furniture. Canton, Illinois (12,000), specializes in plows, lumber and pottery

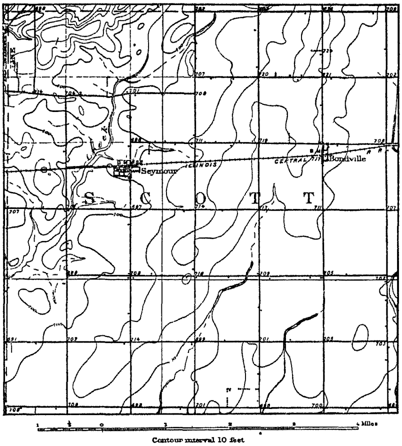


Figure 231 A typical township in the Corn Belt with regularly laid-out farms, usually four or more to a square mile. Each township is divided into thirty-six sections of one square mile in area throughout most of the Heart of North America (Mahomet, Illinois, quadrangle, U. S. Geological Survey)

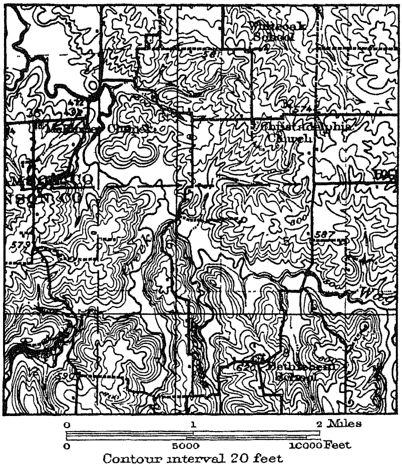


Figure 232. As the Ohio Valley is approached, the topography becomes rolling and then hilly An attempt, only partially successful, has been made to follow the rectangular road pattern Note that the scale is twice that in Fig. 231. (Marion, Illinois, quadrangle, U. S. Geological Survey)

products, and cigars. The three largest cities of the Corn Belt: Indianapolis (387,000), Columbus (305,000), and Omaha (224,000), contain a great variety of commercial and industrial businesses.

The Corn and Winter-wheat Belt. South of the Corn Belt proper, lies an area called the Corn and Winter-wheat Belt. Here the soils are largely unglaciated and are not so fertile as in the true Corn Belt. In addition, the climate becomes sufficiently warm to prevent the growth of corn as good as that farther north. It is, however, produced to some extent throughout the area as a feed for livestock. Soft winter wheat is often raised as a cash crop.

South of the Ohio River the topography is generally rough and farming is consequently not highly developed. There are, however, two areas of limestone soils which differ from the rest of the region. Most important is the Blue Grass region of Kentucky whose rich soils produce some of the world's finest Burley tobacco. Here also excellent grass, rolling topography, and mild climate provide an ideal site for the breeding and racing of fine horses. The Nashville Basin of Tennessee resembles the Blue Grass region in structure and soil; its farmers do not, however, devote as much of their attention to tobacco and horses.

The commercial and industrial heart of the Corn and Winter-wheat Belt is along the Ohio, Mississippi, and Missouri rivers. St. Louis, favored by its superb water and rail connections, is the major distributing center for its own vicinity and also for the South and West. For the same area, St. Louis manufactures machine-shop products, boots and shoes, chemicals, drugs, paints, electrical goods, malt liquors, and a host of other products.

Cincinnati, the leading city on the Ohio, is the distributing center for the rich Blue Grass region. It is located where rail and water routes (including the once important Miami Canal) meet the Ohio. In addition to its importance as an agricultural market, the city is noted for its metal products, soap, clothing, meat and leather products, pottery, and radios. Louisville, the southern rival of Cincinnati in the Ohio trade, has many similar industries.

The Kansas City urban area—Kansas City, Missouri (400,000), and Kansas City, Kansas (122,000)—is much more an agricultural center than St. Louis, Cincinnati, or Louisville. Although somewhat important

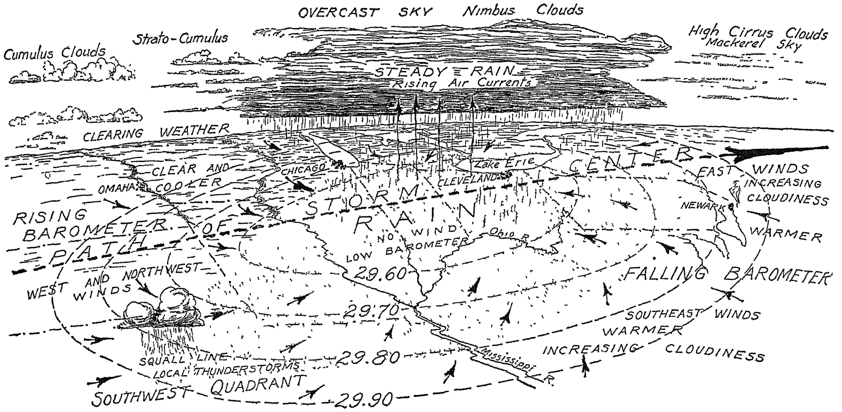


Figure 233 Cyclonic storms (and the thunderstorms which accompany them during the warmer half of the year) account for most of the rainfall in the Heart of North America (From A. K. Lobeck, *Airways of America, Guidebook No 1, United Air Lines,* The Geographical Press, Columbia University)

industrially, its manufacturing is subordinate to its trade in cattle, grain, and agricultural supplies.

The Ozark Plateau. This rugged region occupies nearly half of Missouri and northwestern Arkansas. It is a much-dissected peneplained area, and transportation within it is therefore quite difficult. The people are mountaineers who engage in an almost self-sufficient agriculture—shipping only lumber and apples to outside markets. The greatest contribution of this area to the Heart of North America is mineral, for on its western border is the important Joplin lead and zinc district, while in its northeastern section is another important lead district. There is also a small but growing tourist trade.

The Hard Winter-wheat Region. Southwest of the Corn Belt in the high plains section is a region more than three-fourths of whose cropland is devoted to the production of hard winter wheat. There is too little rainfall for corn, but the soil is generally excellent. It is an area of large farms and machine agriculture, effected by the invariable gamble of one-crop wheat farming.

Toward the eastern part of the belt, where there is more rainfall, some corn and oats are raised, either for grain or to feed farm animals. Toward the drier west wheat farming is combined with ranching. Drought-resistant sorghums, alfalfa, and other feeds are also grown to supplement the natural pasture.

The Spring-wheat Region. This region of rich black soils lies to the northwest of the Corn Belt and is not only too dry but has also too short a growing season for corn Because winters are too severe for grain planted in the fall, spring planting is necessary. The grain germinates and grows rapidly in the summer, when most of the rain falls, and is harvested in the dry late summer and autumn. The swing of this belt westward into regions of very low rainfall in Alberta is explained by the prevailing low temperatures which cause a very low rate of evaporation and thus increase the effectiveness of the small annual rainfall There is less one-crop farming here than in the Hard Winter-wheat Region. Oats, rye, and barley afford some diversification, and a considerable number of cattle are raised All of these activities, however, depend on a distant market, and are vitally affected by fluctuations in rainfall, so farming here is also a gamble.

This is the farthest removed from seaboard of any important crop district on the continent. Many attempts have been made to overcome this handicap through agitation for cheaper freight rates. The Canadian parts of the area have attempted to find outlets over rail routes to the Pacific Coast through Vancouver and Prince Rupert, and to the Atlantic by way of the new railroad to Churchill, on Hudson Bay.

This area has the most continental climate of any

district of considerable population in North America. Edmonton, Alberta, at the northern center of the belt, has a January mean temperature of only 6° F., and a July mean of 61°. Fluctuations about these means are considerable and temperatures of 40° below zero or 110° F. above are not unknown. With these drought and temperature extremes, the farmers of the district live on what may well be a permanent agricultural frontier.

Variable Yields and the Wheat Farmer. The rich black soils of the Western prairies seem to be an agricultural gold mine, but its yield is so reduced by drought, frost, hail, locusts, and plant disease that it is an uncertain resource. Most of these difficulties are beyond the control of the farmer, and the damage is often so great that relief cannot be adequately supplied by the state governments. In 1930, 1934, and 1936 the Federal Government was forced to lend assistance.

Why doesn't the farmer in this region save some of his income for bad years? This question, often asked in the more humid East, can be answered readily. As yet, the Western wheat farmer does not know what the chances of a good or bad year are. Many have saved, and many have had their savings wiped out by a succession of bad years. Statistics are more convincing than assertion, so see Fig. 235.

The Forest and Hay Region. East of the Spring-wheat Belt lies a more humid region which, because of its infertile podzolic soils, has been neglected by the farmer. Once it was heavily forested, but a large part of timber cover in the United States has been removed and that in Canada is now being harvested Minerals, including iron, copper, nickel, cobalt, silver,

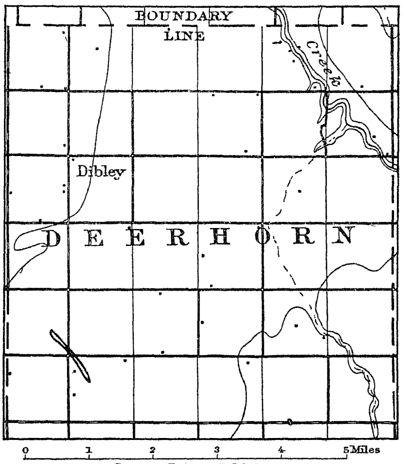


Figure 234. A township in the Spring Wheat Region Deerhorn is located in the Red River Valley, a level area formed on the bottom of the former Lake Agassiz which existed when the continental glacier blocked the drainage toward Hudson Bay Compare the number of houses and roads on this map with those shown on the township in Fig. 231 (Fargo, North Dakota, quadrangle, U. S. Geological Survey)

Figure 235[1]

VARIATION OF SPRING WHEAT YIELDS AT DICKINSON, NORTH DAKOTA

(percentage above or below average yield of 19 3 bushels per acre)

Year	*Yield*	*Probable cause of departure from normal*	*Year*	*Yield*	*Probable cause of departure from normal*
1907	+65%	First crop, virgin soil	1916	+21%	Rain during growing season +18%
1908	+56%	Rain during growing season +10%	1917	−35%	Rain during growing season −43%
1909	+87%	Rain for year +21%	1918	−52%	Second year with low rainfall (−25%)
1910	+12%	Normal year	1919	−80%	Third dry year (rain −52%)
1911	−69%	Serious drought in July	1920	−1%	Normal year
1912	−100%	Hail, July 11	1921	−70%	High evaporation, dry spring
1913	+33%	Benefited from fallow fields in 1912	1922	+55%	Heavy June rainfall
1914	−20%	Too much rain and wind, some hail	1923	−6%	Normal year
1915	+92%	Good and well-distributed rainfall	1924	+12%	Very good season, very high yields reduced by root rot

[1] Abstracted from E C Chilcott, *The Relations between Crop Yields and Precipitation in the Great Plains Areas.*

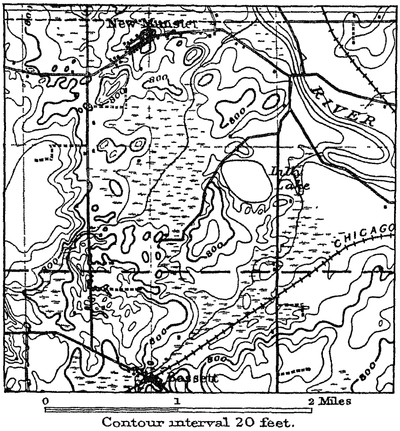


Figure 236. A part of the Hay and Dairying Belt in southeastern Wisconsin. Note the poor drainage caused by continental glaciation. (Silver Lake, Wisconsin, quadrangle, U. S Geological Survey)

are the economic mainsprings of the region, and what agriculture exists finds its market in the near-by mining camps. Hay can be harvested and stored as fodder for the long winter season. On this basis, a dairy industry specializing in cheese and butter has started and may expand.

The Hay and Dairying Belt. The Hay and Dairying Belt largely incloses the Corn Belt on the north and the east. In both directions, the Corn Belt merges into regions in which both the topography and soil are unsuited to any sizable growth of corn. On the east, the hills of eastern Ohio, West Virginia, Pennsylvania and New York are not well suited to machine cultivation and the soil is generally poorer than in the Corn Belt. To the northward, both soil and topography are likewise poor, but the important reason for this part of the region departing from the Corn Belt system is that the growing season is too short for the maturing of corn as grain.

In the hilly or rolling district east of the Corn Belt, the topography is better adapted to grass than to field agriculture, although field crops are grown on the better land. Throughout most of this district, the farmer is relatively near to markets in industrial areas such as those about Wheeling, West Virginia, the Pittsburgh-Youngstown-Akron-Cleveland belt, and Buffalo. All of these factors help to explain the predominance of general farming, with a specialization in dairying. Another specialization is the raising of sheep, largely for meat, especially in the rolling country of eastern Ohio.

The Hay and Dairying Belt, north of the Corn Belt, is also a region of general farming, with dairy products and other items of specialization, but it is much more definitely broken up into subregions. In Ontario, lower Michigan, and southeastern Wisconsin, a near-by urban market is available, and the tendency is for production to be centered on fresh milk. These urban centers alone would largely account for dairying, even if the rougher topography, heavier soils, and shorter growing season did not make this region better suited for dairying than corn.

Most of Wisconsin and adjacent Minnesota are part of the leading American butter- and cheese-producing area. The rolling to hilly topography, the cool, humid climate, and a multitude of human factors (already described on page 176) account for the leadership of this dairy region. Crops are important, but the bulk of them consists of hay, clover, timothy, corn grown for silage, and other fodder crops. Other crops are important in only a few areas blessed with favorable soil or near-by markets, like those to the west of Milwaukee and in northwestern Wisconsin which specialize in green peas; in central Wisconsin and around Minneapolis, in potatoes; and on the southwestern shore of Lake Michigan, in general truck crops.

Fruit growing is another type of specialization in the Hay and Dairying Belt. In most instances it is associated with the Great Lakes, on whose eastern shores the prevailing wind from the water modifies the temperatures and gives frost protection to the orchards. For example, on the eastern shore of Lake Michigan the growing season is one hundred and fifty to one hundred and eighty days, while in central Michigan it is only one hundred and thirty days. The hardy apple is widespread, while the more sensitive crops—peaches, cherries, plums, and grapes—are concentrated on the Door Peninsula, the southeastern shore of Lake Michigan, and other favored spots.

Small manufacturing centers are scattered throughout the Hay and Dairying Belt as throughout the Corn Belt. The industries of these cities are roughly similar to those in the Corn Belt cities. Within the region there is only one outstanding industrial and commercial center: the Twin Cities of Minneapolis-St. Paul.

Minneapolis was originally a lumbering center located at the point where the white pine, floating down the upper Mississippi, was stopped by the Falls

of St. Anthony. Sawmills, operated by water power, were developed to process the lumber. Later, as the Spring-wheat Region developed, and the white pine supply diminished, the industrial emphasis changed to flour-milling. St. Paul had an independent development determined by its site at the head of steam navigation on the Mississippi. With the decline of river navigation, this advantage has almost disappeared. The present importance of the city arises from its factories, stockyards, and its influence as the capital of Minnesota.

QUESTIONS FOR DISCUSSION

1. Compare agricultural conditions in the Corn Belt and the Spring-wheat Region (a review of Chapters 18 and 19 will help).
2. Is the Ozark Plateau well located for summer resorts?
3. Assuming that Fig 235 represents the future fluctuations of crop yields at Dickinson, how large a reserve of wheat should a farmer save in years such as 1907-10 to make up for future poor years? Would such a reserve be held as grain or a cash reserve by the farmer? Would price fluctuations complicate his problem? What other factors are involved?

Industrial Regions

The Allegheny Plateau Industrial District. Bituminous coal, which can be cheaply mined, underlies a large part of the Allegheny Plateau. This, together with natural gas and oil, is the basic resource of one of the leading heavy industrial regions in the world. Pittsburgh, Wheeling, Johnstown, Youngstown, and many smaller cities—all located in river valleys cut into the mature plateau—have important iron and steel industries. Glass and bottle making is another important industry based on cheap local fuel. Due to the availability of cheap labor and huge markets within the area, there are a host of other industries, including foundries, repair shops, food products, and textiles.

The rise of this industrial district took place during the last half of the nineteenth century. Pittsburgh, the metropolis of the area, was founded where a fairly easy route across the mountains met the junction of the Allegheny, Monongahela, and Ohio rivers. It was also at a major eastern gateway to the growing Middle West. This trans-Allegheny route had to compete with the level Hudson-Mohawk route but the Pennsylvania Railroad and the presence of mineral resources, which the Hudson-Mohawk route lacked, made this competition possible. The best coking coal in America (the Connellsville bed), a mediocre supply of iron ore, and excellent limestone were all available near Pittsburgh. The great disadvantage was the limited area of level land along the valleys. This caused industry to spread to many cities along the rivers rather than to concentrate in a few centers.

The best local ore was soon exhausted, and by 1884 it was cheaper to use ore from around western Lake Superior. Consequently, Pittsburgh lost its exclusive advantage of nearness to raw materials. Other iron cities (as Youngstown) grew up on the route from the Connellsville coal fields to the Great Lakes, and finally a new rival arose in the lake-shore iron industry.

The Great Lakes Industrial District. It would be difficult to exaggerate the effect of the Great Lakes on the industrial life of the eastern part of this region. The interconnected series of large lakes offers few barriers to transportation from Duluth to Niagara. In recent years even the barrier at Niagara has been overcome. The Welland Canal, connecting Lake Erie with Lake Ontario, is capable of carrying large vessels into the latter lake. Throughout this lake system there is considerable depth, permitting the use of large, economical ships. In addition, this waterway connects the raw materials and markets of the West with the power, markets, and manufactures of the East. Even the closing of the lakes by ice for three to five months does not prevent them from being the world's greatest inland water route.

Along this route, a number of great industrial areas have developed. The abundant resources of iron ore adjacent to Lake Superior have been available to any port on the lakes. This has resulted in a large movement of ore eastward and southward to the neighborhood of the coal fields and the markets. Coal served as a convenient cargo for the ore cars and boats on the return journey. This made possible lower freight rates for iron ore as well as cheap coal throughout the lake district. The Chicago district (including Gary and adjacent industrial towns) uses coal from southern Illinois and from Pennsylvania (shipped via the lakes) to make many of the iron products that supply the large and growing markets of the Mississippi Valley. The Detroit district, the industrial centers of Ontario and northern Ohio, and the Buffalo district have also used this ore in combination with Pennsylvania coal as a foundation for a tremendous iron and steel industry. Pittsburgh no longer holds the dominant position in this industry, and more pig iron was made in Ohio from 1932-35 than in all of Pennsylvania. Throughout the recent depression, the automobile industry was the largest single user of iron and steel products. As most of the automobiles of the United States and Canada are manufactured in the

Detroit area and adjacent Ontario, it is not surprising that the lake district has grown at the expense of the Pittsburgh district.

The effects of ideal conditions for iron and steel making are not confined to the immediate shores of the lakes, nor solely to the automobile industry. The cheapness of steel has affected the manufacturing structure of most of the country between the Great Lakes and the Ohio River and has even extended as far as St. Louis. Steel from centers on the lakes is used throughout this area in the manufacture of a variety of foundry and machine-shop products, ranging from steam rollers to machine tools and electrical apparatus. In general, interior cities, such as Dayton, South Bend, Indianapolis, and London (Ontario), tend to import steel and make the finer and more finished goods from it. The production of pig iron, rolling-mill products, and heavy iron and steel goods tends to center in lake ports where ore is cheap.

No description of the iron and steel industry of the Middle West would be complete without mention of the manufacture of agricultural machinery. The mechanized farms of this great agricultural region offer a huge market, and fuel and ore are cheaply available. Cleveland, Detroit, Chicago, South Bend, and Moline are all important manufacturers, both for local markets and for export.

Lake transport has also been important in its contribution to other industries. It has brought grain from central and Far Western fields to furnish the raw materials for great flour-milling and brewing industries at Buffalo, Rochester, and in the Ontario peninsula. Even the presence of milling industries at Duluth are due to this transport system, since that city is on the normal routes of grain trade only because it is at the head of the Great Lakes. Timber for a variety of wood products is brought to all of the lake ports from the upper lakes, and Buffalo was, formerly, the greatest lumber market in the United States.

The cities in this lakes district have developed a wide variety of manufactures in addition to those arising directly from the fuel and raw materials made available through lake transport Chicago, for example, manufactures clothing, paints and varnishes, tinware, baking powder, boots and shoes, and, because of its position at the transportation heart of the region, it is the greatest meat-packing center. All these cities have important repair-shop, printing, baking, and confectionery industries characteristic of all large modern communities.

The Ontario District. The important manufacturing area of peninsular Ontario really belongs with the lakes district but deserves separate consideration because of its significance to Canada It is the preeminent manufacturing region of the Dominion and is a large factor in making Canada a manufacturing nation second only to the United Kingdom in the British Empire. Mild climate, abundant water power, proximity to Pennsylvania coal, near-by mineral resources, and Great Lakes transportation—all are favorable factors. The principal cities are Toronto, Hamilton, and London. Its most important industries are milling, meat packing, and the manufacture of pulp and paper, automobiles, electrical apparatus, rubber goods, butter, and cheese.

QUESTIONS FOR DISCUSSION

1. Indicate how agriculture varies from the Corn Belt system in each direction away from the Corn Belt Explain.
2. What are some of the advantages and disadvantages of Pittsburgh as compared with Gary as an iron and steel center?
3. May the western part of this region some day develop an industrial maturity such as that now prevailing in the eastern part? Why?

CHAPTER 41

THE SOUTH

THE SOUTH is the new economic, social and political frontier of the United States In 1938 President Franklin D. Roosevelt characterized the region as the "number one economic problem" of the nation. Here occur the rapid population increases typical of "frontier" conditions, the migration of people, the rise of new industries and the decline of old ones, low per capita average income, interracial problems, changing systems of agriculture and land-ownership, and other phenomena characteristic of a region in a state of flux. While other regions in the United States face many of these problems their severity and speed of change are usually greater in the South.

Here is a region of great natural riches but with a population which has on the average a somewhat lower standard of physical and social well-being than prevails in other sections of the country. Southern leaders and national leaders alike are continuously striving to find the cause for this anomaly and bring to the South the "more abundant life" which the wealth of the region and the quality of its people would appear to make possible.

The South, like any other region, owes its peculiar characteristics to a combination of physical environment and history. In early times there was a general belief that its temperature and humidity were too high to permit white men to perform field labor. Consequently African slaves were imported. They proved profitable under Southern conditions and the Negro became a permanent resident of the South.

The climate has been of greatest significance in its effect on the type of crops which may be grown. For more than a century cotton, which lent itself to the plantation system and slavery, was "king" in the South. This was the largest area in the world that had an energetic ruling class, a reasonably satisfactory labor supply, fairly good soils, a cotton climate, and was favorably situated for export to foreign markets. All these factors stimulated the growth of a social and economic system that had no exact counterpart elsewhere. It was "Southern" and has been, in itself, one of the greatest unifying factors in the region.

But most of the problems of the South today are the result of historical factors more or less disconnected from its physical environment A few are the rise of cotton production in other parts of the world, the appearance of competing textile fibers, the effects of the national tariff, the abolition of slavery, a long and destructive Civil War and the ensuing reconstruction period which disrupted its economic and social system, the freight rate structure, and the mechanization of agriculture. As a result, the South has been almost throughout its history a region of cheap land, poorly paid men, but expensive capital in a nation in which land and capital have usually been cheap and labor well-paid.

The Changing South

For many decades cotton was so profitable that it was raised largely under a one-crop system. While slavery prevailed the large plantation was the unit of production. Since the abolition of slavery a system of tenancy has prevailed. Under this system the tenant, Negro or white, rents the land from the plantation owner and pays his rental either in cash or, more commonly, in a share of the crop. The owner advances credit for fertilizer, seed, and consumption goods, and often lends animals or equipment. Under a one-crop system such an economy is especially precarious and the tenant or sharecropper is often continuously in debt with no likelihood of relief from it. This system has saddled upon Southern agriculture long-term credit, high interest rates, poverty for the tenant, and a temptation to rob the soil to produce more cotton at less expense.

Much has happened in recent years to decrease the dominance of this cotton system. Destruction by the boll weevil, low prices for cotton, and the migration of some of the colored labor supply to Northern industrial districts have all tended to encourage the Southern farmer to seek other crops and other sources of income. This is still the world's greatest cotton-growing region, but it has had to curtail its acreage

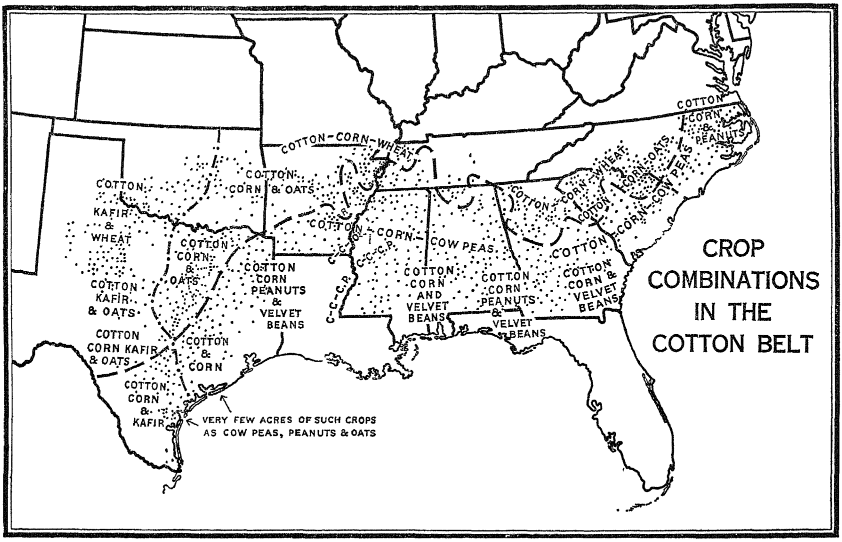


Figure 237 The dots represent cotton production (Courtesy of U. S. D. A)

to meet lower market demands and diversify its agriculture to provide income under the new conditions.

Diversification. The tendency toward diversification has led to the production of increasing supplies of vegetables and animal products for home consumption. Unlike the one-crop wheat regions which do not have a climate which will permit much choice of crops, the South may grow a wide variety. There is no physical reason why the South may not produce grain, pork, beef, dairy products, vegetables, and fruit in sufficient quantities to meet all of its own needs. The dictates of necessity and the urgings of its agricultural experts all point in this direction

Corn is grown very widely in the South, both for human and animal consumption. One of the important directions in which diversification has proceeded has been in the raising of beef cattle and hogs. They are fed largely on corn and other field crops, as the climate in most of the South is apparently not suited to the production of good grass. Dairying is increasing in the vicinity of the growing urban areas.

Two other changes have accelerated this trend. The first is the market for a wide range of agricultural products furnished by the growing industrial areas in the South. The other is the development of fast, refrigerated transportation and canning which have made Northern markets available for Southern fruits and early vegetables

While the latter development has been of some significance over a wide region, there is a tendency for specialized regions of production to spring up where physical conditions are especially favorable and fast transportation is available. Thus, early strawberries are produced in Florida and Louisiana and later, in Arkansas and Tennessee; tomatoes are shipped throughout the winter from Florida, Texas, and Mississippi; and cantaloupes for Northern markets are shipped from Florida, Texas, Arkansas, Georgia, South Carolina, and North Carolina, depending on the season.

Soil Conservation. The South has more serious problems of soil conservation than any other large region in the United States. The two great staple crops, cotton and tobacco, are notorious "soil robbers," especially under a one-crop system of agriculture. As long as good land was plentiful it was common practice to wear out a field and abandon it for newly cleared land. Such a procedure is no longer

possible, and heavy fertilization has become necessary. Cotton and tobacco, together with the newer truck gardening, largely account for the South's consumption of nearly three-fourths of the commercial fertilizer used in the United States. The increasing diversification of Southern agriculture with its crop rotation and manure-supplying animals should decrease the need for fertilizers.

Soil erosion is more serious in the South than elsewhere. This is especially true in the Piedmont where worn-out fields on relatively steep slopes have been abandoned and gullying has been rapid. Even fields which are under cultivation during the growing season must often be planted to "cover crops," such as beans or peas, in the autumn to prevent the soil from washing away. In colder regions, the soil freezes and there is less danger from winter erosion.

The Rise of Industry. The South is the most rapidly growing industrial region in the United States. In former times agriculture was so profitable that the many advantages for industry were largely ignored. In addition, markets were small, due to sparse population and low standards of living, transportation was developed almost entirely to meet the particular demands of agriculture, white labor was unskilled, and the Negro was, and is still, thought to be largely unsuited to employment in factories Since about 1890, however, favorable factors have outweighed the handicaps, and the development of manufactures has been rapid.

The South's Industrial Assets. The principal factors favoring industrial growth in this region include:

1. Cheap labor
2. Cheap land and low taxes.
3. A growing local market and improved transportation to distant markets
4. Diverse agricultural raw materials in large quantities.
5. Great areas of forests, including both hardwoods and softwoods
6. Petroleum in Texas and Oklahoma, copper in Tennessee, phosphates in Florida, sulphur in Louisiana, iron in north central Alabama, bauxite in Arkansas
7. Abundant water power, especially in the Piedmont and the Appalachian Plateau
8. Large reserves of cheaply mined coal in the Appalachian highlands.
9. Relatively lower standards of factory legislation in some states than among their northern competitors

Based upon these advantages, there have arisen a wide variety of industries which may be classified under three broad heads: (1) the cotton-textile industry, (2) industries using other local raw materials, and (3) industries manufacturing especially for local markets.

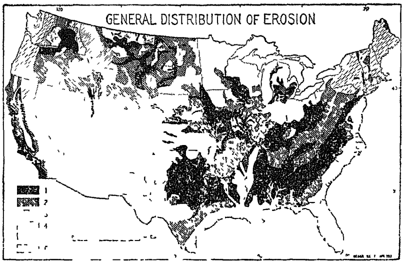


Figure 238. 1 Maximum erosion by water, 2 also serious water erosion, 3 relatively flat lands with some local erosion; 4. hilly lands, erosion not serious; 5. serious wind erosion where land is cultivated; 6. erosion due to overgrazing (From the *Geographical Review*, April, 1935, published by the American Geographical Society)

QUESTIONS FOR DISCUSSION

1. What economic and social characteristics differentiate the South from the Corn Belt? from New England? from the Middle Atlantic States?
2. What are some of the principal economic problems of the South? Are they largely within the region or part of world-wide problems? Explain.
3. In 1919 the people of Enterprise, Alabama, erected a monument to the boll weevil Why might the boll weevil in the long run turn out to be an economic blessing?

Regions

The Piedmont. This region, of relatively minor importance in the North, is a major physical and economic region in the South. It contains the South's largest continuous area of dense population, and within its area are represented most clearly those changes which are converting the old agricultural South into a region of diversified agriculture and industry Half a century ago it could have been divided simply into the Cotton Belt and the tobacco-raising area. Today its growing industries are rapidly justifying the sobriquet applied by many of its boosters—"The Piedmont Crescent of Industry."

The Piedmont starts at the Fall Line escarpment and rises gradually to about 1000 feet at the foot of the first Appalachian ridges. The surface is rolling or hilly and but few conspicuous elevations rise above the general upland level. The soils have been formed by long decomposition from the underlying igneous and metamorphic rocks and are often more than fifty feet deep. There is considerable variation in soil type due to differences in the bedrock, but the predominant type is a red loam, or clay loam, which holds

moisture well, responds to fertilizer, but, unfortunately, is very susceptible to surface erosion.

The climate of the Piedmont is favorable to many activities. The rainfall is adequate for most crops and drought is rare. Because of the elevation, summer temperatures and humidity are less oppressive than in the lowland portions of the South. Moreover, heavy snow or extreme cold is practically unknown and domestic heating plants and heavy clothing are seldom needed, except in the northern portions.

The Piedmont of northern North Carolina and Virginia is especially well suited to tobacco both in soil and climate. There is also present a large supply of the cheap hand labor needed to perform the planting, transplanting, cultivating, harvesting, and curing of tobacco. Much of this work is hard and unpleasant and only a farm tenantry satisfied with a low standard of living would do it. The soil is such that tobacco can be grown on the same field year after year if adequate fertilizer is added.

Beginning in the southern half of North Carolina, the growing season is long enough to insure the ripening of cotton, and cotton becomes the dominant crop. On the northern margin of the cotton area the cool winters have kept the boll weevil in check, but elsewhere cotton is losing ground to diversified farming.

In this southern part of the Piedmont where cotton has been predominant the problems of the agricultural population have become acute. The boll weevil, soil erosion and exhaustion, and competition from the new cotton regions in Texas and abroad have caused whole counties to decline in population and prosperity. Only where manufactures or new agricultural specialties have arisen has anything like a prosperous population been maintained.

Manufacturing. Contrary to common belief, the major advantage of the Piedmont for industrialization is not the presence of cotton, tobacco, or other local raw materials These resources are used, of course, but the cost of shipment to Northern manufacturers in the raw form is little different from the cost of shipment of the finished article. Abundant water power and cheap labor are the great Piedmont advantages. Water power is available in the adjacent Appalachians, along the streams within the Piedmont, and at the Fall Line. As long as water power had to be used at the dam site, the greatest of these sources, the Appalachians, was neglected and the Fall Line cities (including Richmond, Columbia, Augusta, and Macon), which combined water power with position at the head of river navigation, were the best sites for early manufacturing. Hydroelectric power has made wide distribution possible, and through the cooperation of several large power companies it is now possible to transmit hydroelectric power throughout the Piedmont from Alabama to Virginia.

Even more important than electric power is labor. The status of Southern labor is subject to dispute. Labor laws are lax, organization has made little headway, hours are long, and wages are low To the organized labor movement and the New England competitors alike, the Southern industrial prosperity seems to be based on the unfair exploitation of labor. Southern industrialists, however, retort that their workers are contented and that living conditions, if poor among some groups, are, nevertheless, better than the same people formerly enjoyed in their tumbledown farmhouses and mountain cabins. Furthermore, even if unionization forces stricter labor laws and shorter hours, Southern white labor will probably always be cheaper because living costs are lower than in the North. Southern workers have less need for expensive wool clothing, well-insulated houses, and modern furnaces than have workers in New England. Southern food prices are cheaper and rents in mill-owned houses are often nominal. Thus, the wage of the Southern worker in terms of goods and services is somewhat higher than the money wage would suggest.

The industries of the Piedmont are moderately diversified, but the majority are such as require unskilled or semiskilled labor. Most mill labor is white, and Negroes are generally used only for porterage and similar tasks. The cotton-textile industries—including spinning, weaving, knitting, and the manufacture of clothing—are widespread throughout the district. The cigarette and pipe-tobacco industries are localized near the tobacco-raising areas in Richmond, Virginia, and Raleigh, Durham, and Winston-Salem, North Carolina. The furniture industry is localized in a cluster of cities around High Point, North Carolina, and in a string of small cities at the foot of the mountains. Community industries are, of course, found in every city and are especially well developed in such distributing centers as Atlanta and Richmond. The manufacture of ice, ice cream, and soft drinks is especially important among these industries, while baking and canning are of less importance because this type of "manufacturing" in the South is still carried on largely in the home.

The Appalachian Valleys and Highlands. This area is of great importance to the industrial South, for it contributes fuel, power, labor, and raw materials to the adjacent regions and is, itself, a manufacturing area of importance. The raw materials include

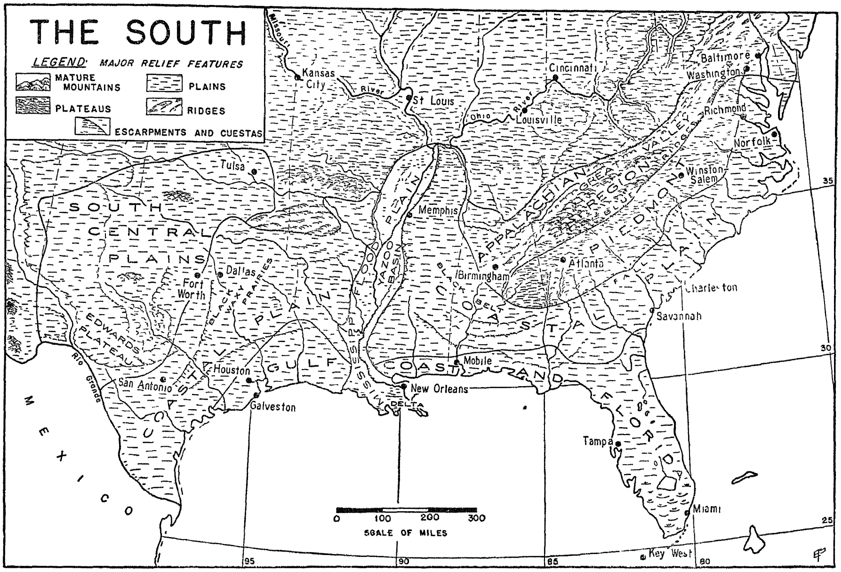


Figure 239.

the hardwoods (oak, walnut, birch, beech, hickory) from the mountains and the iron, limestone, and marble from the Great Valley. The coal of the southern Appalachian Plateau and the water power common throughout this region provide fuel and power. Labor is available not only in the cities of the Great Valley, but, in addition, many of the mountaineers have emigrated to the Piedmont towns. These cool highlands with their excellent scenery are also becoming increasingly popular as a resort area, a development which is being speeded up by the setting aside of a large area in the Great Smokies as a national park and the building of scenic highways

The highland region is generally isolated and poorly developed, for the youth of the plateau and the ruggedness of the more mature mountain ranges make transportation difficult except on the margin. However, there is, within the area, one important exception—the Great Valley. This fertile limestone trough is generally well farmed and well equipped with roads and railroads. At points where passes cross the mountains, important manufacturing cities have grown up (such as Knoxville and Chattanooga, Tennessee, Rome, Georgia; and Gadsden and Birmingham, Alabama) and other minor industrial cities are spaced at intervals between them. Thus the partial industrialization of the Great Valley has made the Southern industrial area into a "horseshoe" by adding a second arm to the "Piedmont Crescent."

The industries of the Great Valley include most of those found in the Piedmont (except for tobacco manufacture) and, in addition, several mineral industries, among which are the manufacture of cement, the quarrying and polishing of marble, and the smelting of copper, aluminum, and iron. Most important of the latter is the Birmingham iron and steel center at the southern end of the valley. It has an almost ideal combination of iron ore, limestone, and excellent coal all within a small radius, but its inland position and the low consumption of iron and steel in the South have prevented it from becoming very large. It will be noted that the manufacturing industries described above are not ones requiring much iron or steel. The South has yet to develop a great number of foundry and machine-shop industries, which are the sign of approaching industrial maturity.

The Coastal Plain. In contrast to the hilly Piedmont, the Coastal Plain is a level area with sluggish streams and frequent swamps. Geologically, this region is young, and the sands which have emerged from the sea within recent geologic periods are rarely consolidated into hard rock. The soils formed from this material range from pure sands to sandy loams. Only in a few places (such as alluvial areas and regions of limey clay) does the soil equal that of the Piedmont in fertility.

The Piedmont is largely farmed, but considerable areas in the Coastal Plain are unused cutover lands or remain in forest. This use is likely to be permanent, for much of the soil is poorly suited to agriculture but satisfactory for forestry and the long growing season produces a lumber harvest in about half the time required in New England In addition, flat topography makes it easy to lay out roads and railroads to bring the product to market.

Since early colonial days this area has been noted for its naval stores; that is, for turpentine, pine tar, pine oil, and resin. Often this exploitation destroyed the forest, for excessive bleeding of the pines for turpentine killed the trees. The shortage of mature trees caused by this wasteful utilization forced the industry to move southwestward from its colonial center in the Carolinas to Georgia, Florida, and Alabama. More efficient methods of extracting these products have been introduced, and it is hoped that the industry will soon be on a permanent basis.

Yellow pine grown on the sandy soils and cypress and gums grown on the moist alluvial and swampy soils are the major timber species. Yellow pine, especially, has contributed to making the South one of the two major lumber regions of the United States. It grows so rapidly that the forest can be thinned every five years, and fifty years suffice to produce a mature tree usable for timber.

Coastal Plain agriculture is rather spotty in its distribution, but these spots are often of great importance. The alluvial soils are heavy producers of high-quality cotton, while the loamier soils of the inner Coastal Plain produce a fair yield with fertilization. Two Coastal Plain areas stand out conspicuously on the cotton map. the calcareous clay areas of the Black Belt of Alabama and the Black Waxy prairies of Texas. The Black Belt of Alabama is especially well known for its large plantations, each supported by a considerable Negro population. This productive area is now shifting to hay and cattle production because the boll weevil was especially destructive there. The Piedmont tobacco belt continues into the Coastal Plain in Virginia and North Carolina, but heavier fertilization is needed, and it is unprofitable to grow tobacco on the same field year after year. Peanuts, largely for human consumption, are raised in a specialized area in eastern Virginia and North Carolina, while another area in southeastern Alabama and southern Georgia specializes in peanuts for hog feed. Peaches are a specialty of the upper Coastal Plain of Georgia and are being grown in increasing numbers in other areas Early vegetables are raised in specialized districts scattered along the through railroad lines.

The mineral resources of the Coastal Plain are small and restricted to a few limited areas. The world's major sulphur-producing field underlies a portion of east Texas In the same neighborhood is the Gulf Coast petroleum field. Phosphate rock underlies the Coastal Plain in several areas in the southeastern states.

Southern Ports. Galveston, Houston, New Orleans, Mobile, Jacksonville, Savannah, Charleston, and Norfolk are the principal Southern ports. The trade of these ports illustrates the relative "youth" of the economic system of the region. All of them are concerned largely with the shipment of bulk commodities, such as cotton, lumber, wheat (from the Hard Winter-wheat Region through Texas ports), phosphate, and petroleum in the coastal, or overseas, trade. The outbound shipments far exceed the inbound which are predominantly fertilizer materials and petroleum. The South is not yet a region which consumes much foreign material, either as direct consumption goods or in its industries.

These ports have not grown so rapidly in recent years as have many of the inland cities. This is largely due to the lack of industrial growth. The functions of the Southern port cities are largely commercial, and any manufacturing they may have is incidental to through commerce. Thus the processing industries —including packing, sugar refining, oil refining, the mixing of complete chemical fertilizers, and the like— are the typical industries.

QUESTIONS FOR DISCUSSION

1. Would the Coastal Plain be able to support many people if interregional commerce were abolished?
2. What is the position of the Negro in the present economy of the South?
3. Look up a railroad map of the South To what extent is the location of the roads controlled by the physiography? Does position explain the importance of Atlanta? of Norfolk?

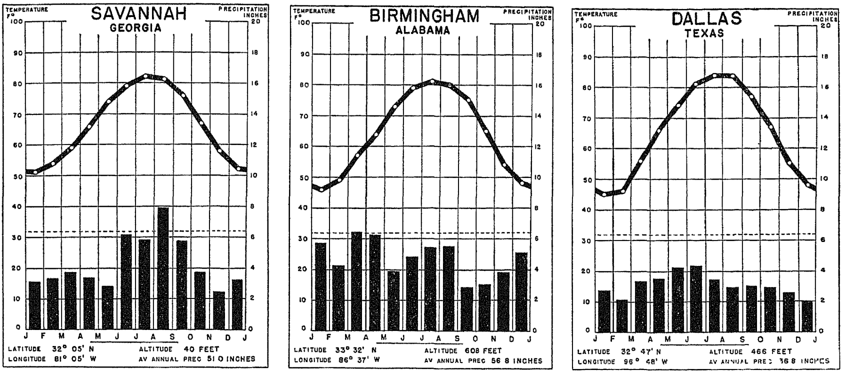


Figure 240. The latitudes of these stations are almost the same Why the differences in climate?

The Gulf Coasts and Florida. Topographically, this region is part of the Coastal Plain, but the longer growing season makes it desirable to consider it separately. Many of the typical industries of the Coastal Plain—lumbering, the production of turpentine, phosphate mining, and the growth of early vegetables, as well as oranges, grapefruit, and sugar cane—are found here. The two southernmost parts of the United States, the Florida peninsula and the lower Rio Grande Valley in Texas, are the only significant citrus-fruit regions east of California. In each, average temperatures are favorable, but occasional cold waves, due to high-pressure areas over the Mississippi Valley, bring frosts which do great damage. Although citrus fruits are grown rather widely as garden fruit from just south of Jacksonville to the tip of the Florida Peninsula, the commercial production is largely confined to the rolling limestone lands in the central part of the state on both sides of a line east and west through Tampa. (See Fig. 239.) The limestone soil is rich and there is less danger from occasional frost on the gentle slopes of the low hills and along the rivers.

In the Texas area the trees must be irrigated, but in Florida the rainfall is sufficient. Grapefruit is shipped from both states, as are oranges which are shipped in small quantities from the coastal districts of Alabama, Mississippi, and Louisiana as well.

The climate of the South is a further asset, in that it offers an escape for those people who wish to avoid the cold of Northern winters and can afford to do so. The Florida cities—such as Miami, Palm Beach, and Tampa—owe their growth to the favorable climate and the excellent facilities for bathing, boating, and fishing Florida lies on the Atlantic Coast, due south of the most densely populated portion of the United States, and is connected to it by fast railroad service. These advantages are not available to many areas with as good sites on the Gulf Coast.

The Mississippi Flood Plain. The Mississippi penetrates the sandy Coastal Plain with an alluvial band, twenty-five miles in width, which has a total area of 30.000 square miles. The lower river is "old" and has meandered considerably The gentle slope of the stream causes it to build natural levees, which in many places have been reinforced by artificial levees. When the spring floods cause the river to rise, these levees are often insufficient to hold it within its banks and the flood plains are inundated. Such flooding fertilizes the soil, but often destroys buildings, livestock, growing crops, and the arteries of transportation

So far, but little of this rich alluvial land has been utilized. The temperatures and the humidity are high, mosquitoes are common, and the river is an annual danger. The Yazoo Basin is being utilized in part to grow long staple cotton and could grow more if the river were better controlled Part of the plain in Arkansas and in Louisiana is used for rice, and the warmest part is used for sugar cane. The mud and water resources yet unutilized surpass those of the Nile, but before they can be fully used it may be necessary to institute flood-control works throughout the entire Mississippi Valley.

The increasing use of the tractor and other farm machinery has decreased the employment of agricul-

tural labor throughout most of the South, especially in the flat Delta and Yazoo Basin lands. Displacement of farm labor is apt to be especially acute in a region such as this where land is owned and managed in large blocks, and there is a specialization on one or a few crops Here the cotton-picking machine has reached its highest development and promises to be most effective in displacing men, thus lowering costs, but creating grave social and economic problems.

South Central Plains. This area is, topographically, highly diversified, but until recently it was a unit in its one industry—grazing. The westward movement of agriculture is, however, gradually displacing the cattle, sheep, and goats Today, this area has a combination of Western and Southern economies. Its crops are Southern, many of its farmers are from the old South, but it is distinguished from the old South by its irrigation and dry-farming techniques, its larger farms, and small colored population.

The Edwards Plateau, in south central Texas, still retains its Western economy. Its principal products are wool and mohair. Animal industries are likely to remain here, for the soil is thin, porous, and stony. Rainfall is low, considering the high temperatures, and is inadequate even for cotton except on the eastern edge of the plateau.

The Rio Grande Valley was much like the Edwards Plateau in products until irrigation unlocked its agricultural resources. The southeastern end of the valley has rich soil and is subject to frost only four to six weeks each year. Winter vegetables and citrus fruits are raised near the river, while a short distance away from the stream there is only cattle raising. Farther inland, the winter weather is more severe and irrigated cotton replaces winter vegetables as the major crop. Long-staple cotton, grown under irrigation, is especially important along the river near El Paso.

Northwestern Texas is another cattle area in a state of transition. Its rainfall ranges from sixteen to thirty inches; its calcareous, loamy soil from medium to high fertility; its topography from gently rolling to extremely flat. Under former conditions during the rainy season (summer) its streams were filled, and pools stood in many of the depressions in the flatter areas. In winter, and during drought years, water was a scarce commodity and duststorms were common.

A recent government report describes the transformation of these Texas plains:

> The most significant phase of the agricultural growth of this district has been the recent spectacular development of cotton production. When this country was first opened up it was thought suitable only for grazing purposes, and the livestock industry held undisputed sway. With the construction of additional railroads and the improvement of transportation facilities the possibilities of farming began to be recognized and some ranches were divided up into smaller holdings Cotton was found to be well adapted to growing conditions, but it was only after the World War that the great expansion in acreage took place. The current difficulties of the cattle industry together with the good prices for cotton gave a great impetus to cotton production. . . . The boll weevil has not invaded this district, and the chief factors limiting the further extension of the cotton acreage are rainfall and the length of the growing season The cotton produced here is of the short-staple upland type [1]

In the northern part of the Texas Panhandle, a similar transformation has occurred but the cash crop is winter wheat.

QUESTIONS FOR DISCUSSION

1. Account for the development of Vicksburg, Houston, Galveston, San Antonio, Fort Worth, Dallas, El Paso.
2. Look up in a large atlas the railway net of Texas Where is it best developed? Where are railways almost lacking? Explain.
3. What difficulties prevent the complete utilization of the soil resources of the lower Mississippi basin?

[1] Alma S Moulton, *Cotton Production and Distribution in the Gulf Southwest*, pp 16-17, Part III of the *Commercial Survey of the Gulf Southwest* United States Government Printing Office, Washington, 1931.

ANALYSIS OF PLATE XVI: THE SOUTH

XVI A. The rolling Piedmont lands of the South are especially subject to severe erosion. On the land in this photograph, plowing and cultivation incidental to raising cotton have loosened the soil year after year. During the winters, the field has lain bare and the soil, not being frozen in this mild climate, has been eroded by the runoff from every rain. In the foreground, the field has been eroded right down to the heavy clay of the "C" horizon.

XVI B. Here Piedmont land, similar in climate and slope to that in the preceding photograph, has been so utilized as to reduce erosion Plowing and cultivation are along the contours to reduce wash to a minimum and strips of fodder crops between cultivated belts slow down the runoff and catch any soil that may be washed from the cultivated strips.

XVI C The unpainted board cabin is this sharecropper's only building and the only roof under which he may store his cotton temporarily is on his front porch. The sharecropper often moves on after a year or two so there is little incentive to make any improvements about the place

XVI D. This sharecropper in his patched trousers is cultivating another man's land with horses and a cultivator not his own. He lives from one crop to the next on credit

XVI E. A typical scene in the forested coastal plain of the South where timber is the principal resource and the sluggish rivers furnish cheap transportation.

XVI F. In the flatter lands of the drier western parts of the South, grain farming predominates. This field has been plowed and planted along the contour to reduce sheet erosion on even this gentle slope.

CHAPTER 42

THE WEST AND THE FAR NORTH

THE PHRASE "the West" has a definite meaning to most Americans and Canadians. It calls up a picture of a new country of great plains and plateaus, of mountains that rear their summits into the zone of perpetual snows, of deep canyons and swift rivers. It is a land where the Indian still survives, where in large areas cattle- and sheep-herders are the only inhabitants, and where mining and prospecting are still important occupations. This is the country of the "Western" novel and the "Western" movie thriller, and although some of the glamour is gone in these days of fenced pastures, dude ranching, and air-conditioned trains, much of the West has not "grown up," and probably never will.

As settlement moved westward during the nineteenth century, each part of the continent went through the pioneer stages of existence; then the frontier pushed on, population increased, and the empty spaces were filled up. All this held true until the frontier reached about the 100th meridian, and then the process changed. Exploration and settlement moved on westward until the Pacific was reached, but much of the country left behind continued to be sparsely settled, the pioneer industries remained, and there were large areas of "frontier" within the wider bounds of settlement. This change in the process of settlement was due to a fundamental difference in the nature of the country: most of the West is too dry or too rugged for ordinary agriculture. This is a situation which time, increasing population, and better transportation cannot change. This "frontier" is destined to last until man acquires new techniques which will enable him to use lands with low rainfall and steep slopes.

Like so many geographic boundaries, the specific line at which the West begins is difficult to draw. On the east, this line is often considered to be the boundary between the land with sufficient rainfall for ordinary field agriculture and country too dry for crops without irrigation or dry farming. But this line is not fixed: it moves eastward during dry years and westward during rainy years. On the average, the twenty-inch isohyet represents the division except in the north where lower evaporation permits agriculture with less rainfall. Thus in Canada the agricultural region extends to the foothills of the Rockies.

Regions

The West has greater topographic diversity than any other portion of North America, and the physical regions are generally large. In fact, so vast is the area included in the West that many of its regions are very broad and might properly be subdivided if their economic development justified a more detailed discussion.

The Great Plains. West of the crop belts, this region, once the home of great herds of bison, rises in a series of great "steps" to the foot of the Rockies. Here are broad stretches of semiarid, grass-covered, flat or gently rolling plains, suited mainly to cattle ranch-

ANALYSIS OF PLATE XVII: THE WEST

XVII A This citrus-fruit area is made possible by irrigation water from the stream which descends the canyon from the snow-covered mountain in the extreme background Where the stream leaves the mountains an alluvial fan has developed. Figure 96 (page 145) is a contour map of a similar development on an alluvial fan.

XVII B Scrub forest and grassland in the semiarid country in southwest Texas between the Rio Grande and the Pecos Note that even the scrub forest exists only where some moisture remains in the gullies after the infrequent rains.

XVII C. The usable land lies along both sides of the river between the irrigation ditches (marked by the lines of trees and the edges of the cultivated area) and the river itself Drainage ditches carry surplus water from the irrigated fields into the river

XVII D The apple orchards in this valley are irrigated by water from the canal which runs along the base of the hill. The sparse forests on the hillsides indicate that the climate is semiarid.

XVII E. The dumps so prominent in this picture represent the refuse from the copper smelter. There is no vegetation in the immediate neighborhood because of the fumes from the smelter The myriad of wires indicates the importance of electric power here in the mining, handling, and smelting of the ore.

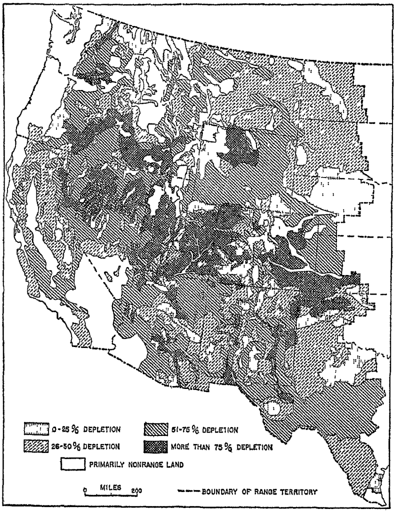


Figure 241. The degree and extent of forage depletion on western ranges. (From *The Western Range,* Senate Document No. 199, 74th Congress, 2nd Session)

ing, sheepherding, and the precarious growth of fodder and grains by dry-farming methods Property holdings are large, as they must be where pasture is so poor that it often takes one hundred acres to support one steer Along streams flowing eastward or southward from the Rockies water for irrigation is available, and, especially in eastern Colorado, specialized regions of intensive sugar beet, grain, melon, and vegetable production have been developed. Hay and fodder are also raised by irrigation to supplement the poor pasture of the plains.

Population is sparse except in a few oases where irrigation is available. The few large cities, all located on the western margin of the plains, grew because of the resources of the Rockies rather than those of the Great Plains. The transportation network is an "open" one. There are few branch-line railroads or paved side roads, and the trunk lines of the railroads and highways pass as straight across the region as possible.

The Great Plains are far from uniform. Their temperatures and crops vary from south to north, the rainfall decreases from east to west. In general, they may be subdivided into three widespread types:

1. The farm-grazing belt, which is but a continuation (with dry-farming methods) of the Spring- and Winter-wheat belts to the east The farms have to be much larger to compensate for the lower per acre yields, and to provide pasture for the cattle The cattle use the grain crops as fodder if the weather does not produce a grain harvest
2. The grazing-forage belt consists of still larger farms Cattle predominate, and crops are decidedly subordinate to them Normally the crops are raised primarily for forage by dry farming or irrigation.
3. The arid grazing areas contain only poor pasturage and are generally used for sheep rather than cattle These are not continuous but occur within the grazing-forage belt where rain shadows, porous soils, or similar conditions reduce the humidity

Fluctuating rainfall makes it difficult for the settler to determine in which type his particular land belongs. About 1880-85 the Great Plains had a period of unusually high rainfall. Many farmers entered the area, harvested a few good crops, and then found that a longer period followed with much lower rainfall. Many were driven back East by the drought, and the country returned to the cowboy and the sheepherder.

In the twentieth century another generation of farmers, equipped with better dry-farming techniques, again plowed the land. Bowman describes how some of these adjusted their farm life to the uncertain climate:

> The wet and dry periods have taught the farmers how to get along. They have experimented with the different sorghums and from them obtain crops in almost any year. They have learned how to have in sight at all times a two-year supply of forage for farm animals instead of importing expensive feed in dry years. A windmill supplies water sufficient to irrigate a small garden Surplus stock can always be sold to pay the taxes Having weathered the droughts of 1910 and 1918, they have learned how to meet the next one "which is sure to come." [1]

The problem, however, is by no means so simple as the above quotation may suggest The plowing of the soil has encouraged duststorms. A long dry period may require much more than a two-year forage supply. Finally, there is the economic factor—will the price in the world market be high enough to repay the dry farmer for his labor after he has paid his freight and other expenses?

The Great Plains have some mineral resources, but they are of minor importance to the district as a whole. Oil is pumped in the Texas Panhandle and in Wyoming. Inferior bituminous coal and lignite are widely distributed but rarely mined except near the foot of the Rockies. Salt, gypsum, and potash complete the list of mineral resources.

The Rocky Mountains. These mountains are not a single chain but a broad, discontinuous area of high

[1] Isaiah Bowman, *The Pioneer Fringe,* p. 118 Special Publication, No. 13, American Geographical Society, New York, 1931.

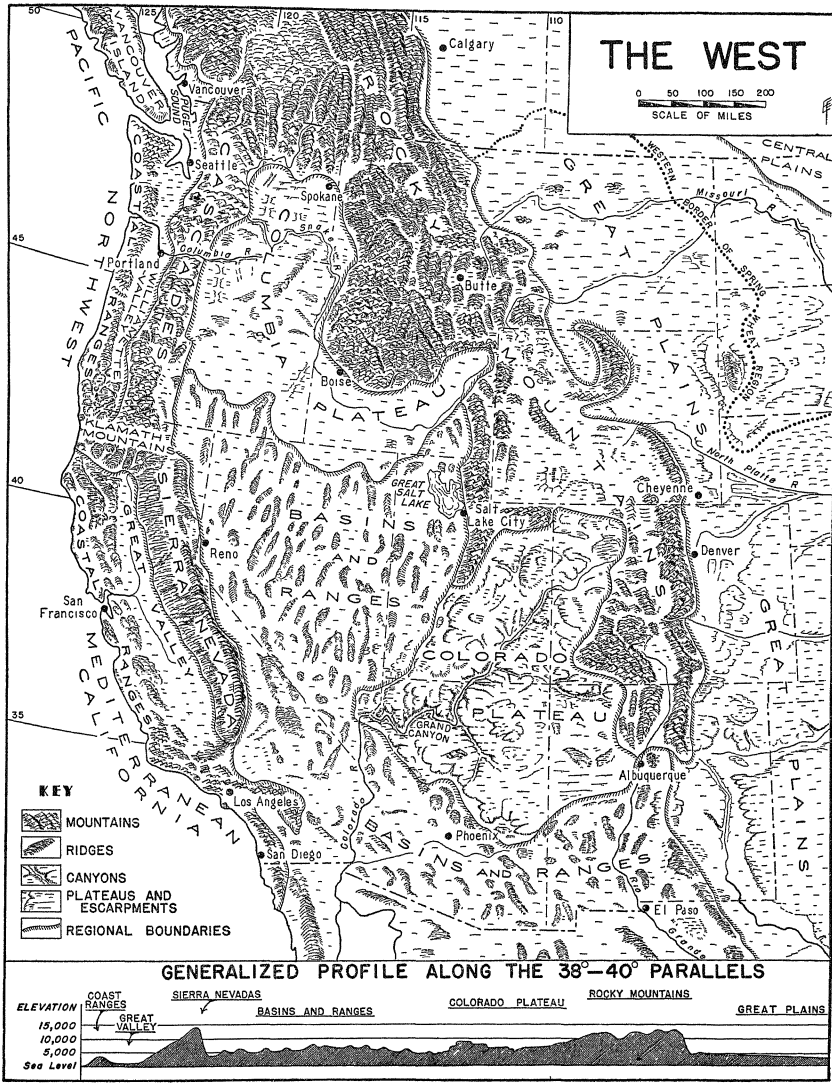

THE WEST
0 50 100 150 200
SCALE OF MILES
PACIFIC NORTHWEST
VANCOUVER ISLAND
PUGET SOUND
Vancouver
Seattle
Spokane
Portland
Calgary
Butte
Boise
CASCADES
COAST RANGES
WILLAMETTE VALLEY
COLUMBIA PLATEAU
ROCKY MOUNTAINS
GREAT PLAINS
CENTRAL PLAINS
WESTERN BORDER OF SPRING WHEAT REGION
Missouri R
Columbia R
Snake R
North Platte R
KLAMATH MOUNTAINS
SIERRA NEVADA
GREAT VALLEY
COASTAL RANGES
MEDITERRANEAN CALIFORNIA
San Francisco
Reno
GREAT SALT LAKE
Salt Lake City
BASINS AND RANGES
Cheyenne
Denver
COLORADO PLATEAU
GRAND CANYON
Albuquerque
Los Angeles
San Diego
Phoenix
El Paso
Colorado R
Rio Grande
KEY
MOUNTAINS
RIDGES
CANYONS
PLATEAUS AND ESCARPMENTS
REGIONAL BOUNDARIES
GENERALIZED PROFILE ALONG THE 38°—40° PARALLELS
ELEVATION
15,000
10,000
5,000
Sea Level
COAST RANGES
GREAT VALLEY
SIERRA NEVADAS
BASINS AND RANGES
COLORADO PLATEAU
ROCKY MOUNTAINS
GREAT PLAINS

Figure 242.

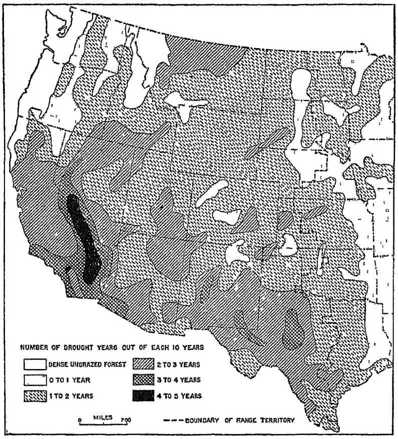


Figure 243 The Western farmer needs a reserve for drought years except in the Pacific Northwest. Is the data shown here of much concern to the irrigation farmer? (Courtesy of U. S Department of Agriculture)

young mountains divided into numerous ranges. With a few exceptions, the mountains rise high enough to serve as a serious barrier and to wring some rain from the winds. Ascending almost any of the mountain slopes, the grasslands of the plain change gradually into an open pine forest (with sufficient grass for pasturage between the trees), and at the timber line the forest is replaced by an alpine pasture which in turn gives way to rocky, snow-covered peaks. Snow-fed streams supply irrigation water to adjacent plains and fertile valleys which streams have cut and filled between the ranges. Level or hilly intermontane upland areas, known as *parks,* often have good soil and plentiful herbage. They are excellent for grazing and in the Southern Rockies are often warm enough for agriculture.

Agriculture in the mountains reflects the isolation and the nature of the topography. Grazing is carried on wherever slopes are gentle enough and rainfall sufficient for grass to grow. The industry is often migratory, with sheep and cattle being driven to mountain pastures in summer, returning in winter to warmer conditions in the lower areas. On the flat irrigable lands near mining and tourist centers, general farming with a dairying or vegetable specialization is carried on. The farmer has a virtual monopoly of his local market because of distance from competitors and high freight rates, but he is handicapped by the same factors if he attempts to ship his products to distant markets. Only a few specialties, such as Idaho potatoes and Colorado peaches and lettuce, will stand the transportation costs.

The tourist industry contributes a large part of the income of many mountain regions. The scenery is striking and varied, summers cool, and hunting, fishing, and camping conditions excellent. The industry has been organized by Federal and state governments, by the transportation companies, and by businessmen; comfort is assured wherever the scenic and recreational advantages are greatest.

Along the eastern edge of the Rockies in Alberta, British Columbia, Montana, and especially Colorado, low-grade coals underlying the Great Plains have been compressed by the mountain-making forces, and some high-grade coal is mined. In the Pueblo district in Colorado, it is of sufficient quantity and quality to give rise to an iron and steel industry using local iron-ore supplies. The iron and steel products supply the Western interior markets.

The Rockies have many physical resources favorable to manufacturing, but are too far from market to compete with regions of better position. Water power is abundant, and timber and ores are present in wide variety; thus they form the basis for the principal industries, other than the iron and steel mentioned above Smelting of ores is important in Montana, Utah, and Colorado. Other manufacturing industries are almost entirely for the local market.

Mining has provided the economic impulse for the development of the Rockies. Important centers of population are all located near mines, and most other industries owe their origin to the demands first created by the mining industry.

It is convenient to divide the Rockies into three subdivisions: the Southern Rockies of Colorado; the Central Rockies, located mostly in Wyoming; and the Northern Rockies, extending north from Yellowstone Park. Each group has its peculiar characteristics, although the trend of all the ranges, and many of their structural features, are similar throughout.

The Southern Rockies. The most thoroughly exploited subdivision is the Southern Rockies. They are relatively simple in structure: most of the ranges consist of a simple fold within which is a crystalline core. Streams such as the Platte, the Arkansas, and the Rio Grande cut across the ranges and make penetration into the mountains relatively easy. Throughout the crystalline core are found veins of silver, gold, lead,

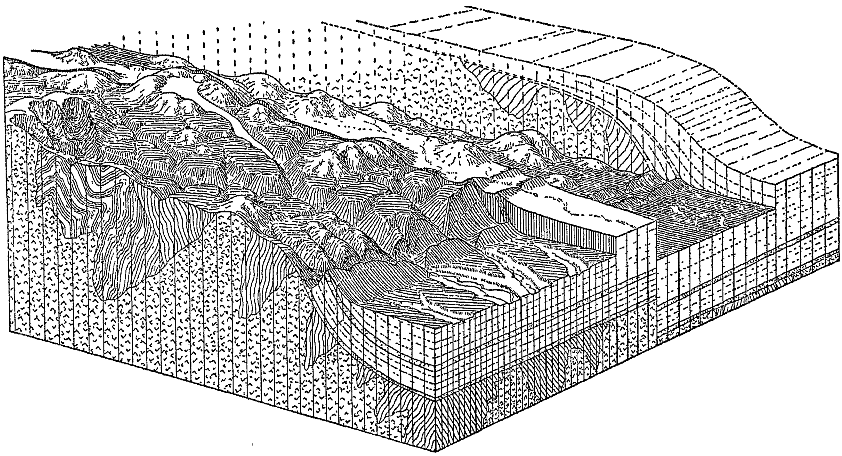


Figure 244. A diagram to show the geological history of the Front Range of the Southern Rockies. The section to the right represents the strata at the beginning of a cycle of erosion The next section represents the last stages in that cycle The area was then raised by crustal movement and a new cycle of erosion was started. The present topography is shown by the section to the left. (From W M. Davis, "The Colorado Front Range" in *Annals of the Association of American Geographers,* Vol. I)

zinc, copper, iron, manganese, tungsten, molybdenum, and bismuth.

The discovery of precious metals led to the development of the area and to the growth of such isolated places as Leadville (altitude 10,190 feet). Leadville provides a striking example of the rise and decline of mining towns. Gold and silver veins were discovered in the vicinity about 1850; by 1880, the population of the town was 35,000; today the richest ores have been exhausted, and today the population is only 4,774. Many other towns have had a similar history.

The cities that grew up at the eastern edge of the Southern Rockies were originally supply centers for the mining camps They now assemble and repair mining machinery, handle shipments of foodstuffs and other supplies, and perform many political and commercial services for the mining areas and for those agricultural areas which supply food to the mining camps. A few of these cities, like Denver and Colorado Springs, have lost their complete dependence on mining, although the prosperity of all is still vitally influenced by mining conditions.

The Central or Middle Rockies. The high wall of the Rockies stops at approximately the northern boundary of Colorado and leaves open a wide gateway used by railways, highways, and air lines. The bulk of this area is occupied by the Wyoming Basin, a higher and drier continuation of the Great Plains. In and around this basin are isolated ranges of mountains which are not sufficiently mineralized to attract any large population. Although oil has been discovered and exploited here, at present most of the area is only sparsely populated by sheepherders.

The Northern Rockies. The northern ranges are structurally much more complicated than those to the south. The mountains generally consist of complex mixtures of folded and faulted strata interspersed with igneous intrusions. Glaciation has broadened the valleys and added to the grandeur of the peaks. The rainfall, much heavier than in the Southern Rockies, accounts for dense forests, flourishing agriculture in the valleys, and heavy snow cover on the peaks.

Mining is concentrated in two districts where intrusive rocks have brought ores near the surface. The Butte district of Montana was first developed in 1864 as a gold and silver region. The richer ores were soon exhausted and the tremendous copper resources were exploited instead. In 1883 at Anaconda a smelter was erected which used the low-grade coal (lignite) of the Great Plains to smelt the local ores. For half

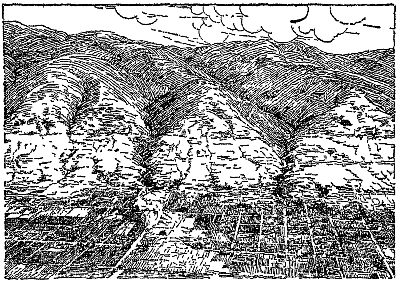


Figure 245 A sketch of an irrigation settlement at the foot of the Wasatch Mountains of Utah The vegetation along the sides of the center canyon has been destroyed and flood waters have washed alluvium over the fields at the canyon's mouth. The resulting deposit (an alluvial fan) may, after many years, become a rich agricultural area. (From *The Western Range*)

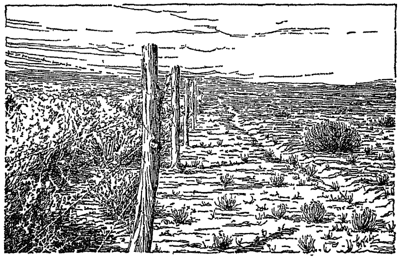


Figure 246 Originally the vegetation on both sides of the fence was the same. Long-continued overstocking of the range on the right has resulted in the disappearance of the valuable saltbrush (still abundant on the protected range across the fence), a thinning of the sod, and an increase of small, worthless shrubs The net result is a greatly reduced grazing capacity. (From *The Western Range*)

a century, this area has been among the world's leading copper producers.

The smaller Coeur d'Alene district of Idaho mines silver-bearing lead ores which are concentrated locally and shipped elsewhere for smelting. Zinc and copper are important by-products.

The Colorado Plateau. This is the supreme example of a young plateau. From many of its summits the whole country seems level, but when the traveler tries to cross it he comes to sharp canyons, often much deeper than they are wide. Each canyon shows by its multicolored strata a large slice of the geological history of the region. This mile-high country is often awe-inspiring, but otherwise of little use. The tourist business of the Grand Canyon and a few sheep and lumber centers make up almost the total use which white men have made of the plateau. Most of it is left to the Hopi and Navajo Indians who live by sheep-raising, agriculture, and the sale of rugs, blankets, and souvenirs to tourists.

The Basins and Ranges. West and south of the Colorado Plateau is a huge, sparsely populated area of arid ranges and basins. Faulting has formed numerous block mountains, mostly trending north and south, and has thus subdivided the region into many smaller units. Nevertheless, except where mineral deposits or irrigation have formed islands of economic activity, the area is a unit in its lack of value for anything but the most extensive form of grazing.

The Great Basin. The northern half of this region, including most of Nevada and nearly half of Utah, is an area of interior drainage known as the Great Basin. The prevailing altitude (4000-5000 feet) gives this region cold winters and cool summer nights. Except along a few through routes, little is to be seen except sagebrush, block mountains, and desert basins.

The Salt Lake City area is the most highly developed part of the region. Here the Mormons settled in 1847, and established, in time to supply the "Forty-niners" en route to California, the first large irrigated area in the United States. Later copper, silver, lead, zinc, and gold deposits were discovered in the near-by mountains, and mining camps provided a large market for the irrigation farmers. Sugar beets, fruits, and other specialties were later added to the crops of this well-tended oasis.

On the western edge of the Great Basin is the Nevada gold- and silver-mining district. As in the Southern Rockies, irrigation farming has developed to supply local markets. Recently mining has spread into parts of central Nevada and copper, lead, and zinc deposits have been discovered whose present yield greatly exceeds in value the output of the gold and silver mines.

The Arid Southwest. Lower latitudes and altitudes make the southern half of the Basins and Ranges Region subtropical in climate and products Winter vegetables, long-staple cotton, subtropical fruits, and fodder crops are raised in the irrigated areas, especially in the Salt River and Imperial valleys. In Arizona, the copper produced is more than twice as valuable as the agricultural products of the oases.

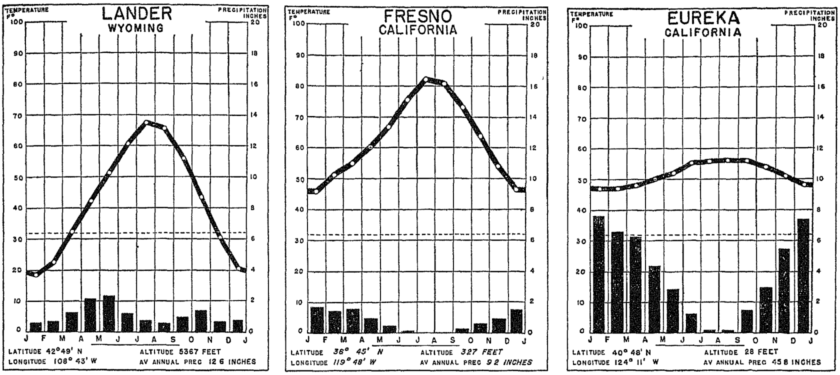


Figure 247. Although most of the West is semiarid, differences in latitude, altitude, and exposure to the winds and sun cause great differences in climatic conditions

QUESTIONS FOR DISCUSSION

1. Where does the West begin? Will the West ever resemble the Eastern region (economically)? Why?
2. It has been said that the intermontane regions would be much improved if the adjacent mountains were lower. Why? Would there be any disadvantages?
3. Examine a railroad map and a physical map of the West Account for the growth of cities at Salt Lake City, Spokane, and El Paso.

The Pacific States

The Columbia Plateau. The intermontane area of Oregon, Washington, and Idaho (250,000 square miles in area) is covered by a thick layer of extrusive volcanic rock which decomposes into a very fertile soil This huge area, known locally as the "Inland Empire," has one great misfortune, its semiaridity. However, the extremely level lands are well suited to machine agriculture, and by the use of extensive dry-farming methods heavy yields of winter wheat are obtained. The Snake and Columbia rivers and their tributaries are largely used for irrigation and water power Potatoes, fruit, and alfalfa (fodder for livestock) are the important crops. The production of apples in some of the valleys of eastern Oregon and Washington and southern British Columbia is especially interesting. Most of these valleys open out into the intermontane basins and have, therefore, low rainfall and abundant sunshine. Water is supplied by irrigation, and this control of the water supply, combined with abundant sunshine, produces a uniform product of excellent appearance. Growers are highly organized into cooperatives which market the product very efficiently in Eastern and even European markets.

The Sierra-Nevada-Cascade Mountains. This high mountain barrier is both the making of the Pacific states and the undoing of the intermontane basins. The winds passing up the westward slopes drop their moisture either over the Pacific valleys or into the streams which irrigate them. In winter, this moisture is stored as snow on mountain slopes. It melts the following summer, when the annual dry season in the valley makes additional water essential.

The Sierra Nevada range is quite different from its northern neighbor, the Cascades. It is a huge block mountain which has its steep face on the east and a long slope on the west. Glacial action has cut huge U-shaped valleys in the western slope, such as the much-visited Yosemite. Great forests cover the slope and regulate the flow of water to the valley as well as add to the scenery.

The Cascades are volcanic peaks which stand on a wide plateau. They intercept even more moisture than the Sierra and are covered on the west side by the moisture-loving Douglas fir, while the drier eastern slope is occupied by yellow pine. Lumbering is the principal occupation and, except for the tourist trade and agriculture in the valleys, the only occupation.

Mediterranean California. The irrigated valleys of California are indeed the gift of the mountains. The Great Valley (40 miles wide and 400 miles long) was probably a former arm of the sea which has been

filled up by the deposits borne by the streams of the Sierra Nevada and the Coast Ranges. These same streams irrigate the valley. West of the Great Valley are the Coast Ranges, which run roughly parallel to each other and inclose a number of fertile alluvial valleys. North of the Great Valley, the Coast Ranges join the Sierra in the mountain block of the Klamaths which reaches to the coast. The rugged Klamaths are a sparsely settled, humid area, with a dense cover of firs which is the basis for an important lumbering industry.

Most of this area has a Mediterranean climate with a generally low rainfall and a winter maximum that makes this precipitation largely ineffective. In general rainfall increases from south to north. On the coast the annual average is less than fifteen inches south of Los Angeles and slightly more than twenty-five inches north of San Francisco. The Coast Ranges receive more rainfall, while the interior valleys are too dry, even north of the central part of the state, for agriculture without irrigation or dry farming. Temperatures are mild, except away from the coast in the interior valleys where summers are very hot.

Agriculture. In spite of its low rainfall, the dominant industry in Mediterranean California is agriculture. Although there is a large population, especially in the coastal cities, local markets consume only a small part of the crops. The development of canning and high-speed, refrigerated transportation has extended the market to the more densely populated Eastern states and has allowed Californian agriculture to attain its present importance.

Fruits are the most important type of crops. Citrus fruits, such as oranges and lemons, are grown under irrigation in the valleys about Los Angeles and in the Great Valley wherever the winters are mild enough or air drainage is favorable. Temperate fruits, such as peaches, apricots, pears, and cherries, are ideal for canning, as abundant sunshine and the control of moisture supply through irrigation gives a uniform product. Vegetables, grown for winter sale in Eastern markets and for canning, are also important. Grapes—marketed as wine, fresh fruit, or raisins—and walnuts are two important specialties.

Mixed farming, often with a vegetable, fruit, or dairying specialization, is carried on throughout the region wherever conditions are favorable. Dairying thrives in the valleys of the Coast Ranges near San Francisco and in the hills near Los Angeles. The Great Valley above the latitude of San Francisco receives sufficient rainfall, so that dry farming, rather than irrigation, predominates, and grain, usually wheat, is the principal cash crop. Near Sacramento, rice is a major crop on waterlogged soils not suited to other uses. Cattle occupy the drier or hillier land.

California has a very highly developed agriculture. Intensive development, irrigation, and cooperative marketing have overcome the handicaps of isolation and low rainfall. The irrigated fruit and vegetable lands are the most valuable agricultural acreage in the United States.

Gold and Petroleum. Although gold was largely responsible for the early settlement of California, and that state is still the nation's largest gold producer, mining is not a widespread industry. The mineral product of greatest importance is petroleum, which is produced in the region about Los Angeles and in the southern end of the Great Valley. In most years, California ranks either second or third in petroleum production.

Manufacturing and Commerce. Manufacturing in California is of two types: (1) that depending on local resources, and having important distant markets, (2) community industries, supplying primarily the local market and sometimes having an export surplus for Pacific markets.

In the Los Angeles district, local fruits, vegetables, fish, borax, and petroleum are packed and processed by the first type of industry. The motion-picture industry uses the varied scenery of the surrounding country, as well as the excellent light conditions and mild climate which permit year-round production schedules. The aircraft industry has also been attracted by the mild weather. Ordinary community industries, such as baking and printing, are important, as well as the production from imported materials of tires and tubes, electrical equipment, foundry and machine-shop products. Some goods of the latter group are exported

The San Francisco-Oakland district has a much better harbor than Los Angeles and its commerce is greater. With the exception of the motion-picture industry, its manufacturing is very similar to that of the Los Angeles district.

The Pacific Northwest. This region occupies the area west of the Cascade Range and north of the Klamath Mountains. In the United States the broad Willamette-Puget Sound Valley lies between the Cascades and the Coast Ranges; but in British Columbia the Coast Ranges are represented only by Vancouver Island and a chain of smaller islands off the coast—the valley lying between them and the Cascades becomes an arm of the ocean. This territory has a ma-

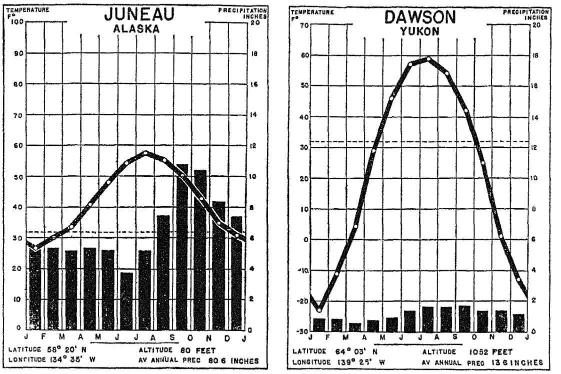


Figure 248.

rine west-coast climate like that of the British Isles, with an abundance of rainfall except in some interior valleys. The heavy rain results in a dense and valuable forest cover which is one of the region's main assets. The heavy rain on mountains near the sea gives rise to tremendous potential water power, either in the region itself or in the neighboring mountains.

Agriculture. The farms of the Pacific Northwest resemble those of the Hay and Dairying Region, but dairying is less important due to the smaller local market Most of the farms add to general farming specialization in fruits and berries, many of which are canned and shipped to the East. The Willamette-Puget Sound Valley, especially south of the Columbia River, is the agricultural heart of the region. Elsewhere leached soil and heavy forests (or their stumps) make it hardly worth while to expand agriculture for the limited local market now available.

Manufacturing and Commerce. Manufacturing here is similar in type to that of California, although it varies in details. Flour milling, pulp manufacturing, saw-milling, and the canning of fruits and fish are closely tied up with local resources. The fisheries, although second in importance to those in the East, are a leading local industry. Community industries are also present, as well as a few other industries (such as shipbuilding) attracted by cheap water power and small coal deposits. The ports of Portland, Seattle, Tacoma, and Vancouver handle a large foreign and coastwise trade in the products of the region as well as in valuable Asiatic products.

QUESTIONS FOR DISCUSSION

1. Describe the characteristics of the Mediterranean climate and indicate the ways in which it is an asset or handi cap to California
2. Why is Vancouver the largest Canadian city west of Toronto? Why has Los Angeles become the largest city west of St. Louis?
3. Which should become most important in the future, the California coast or the Pacific Northwest? Why?

The Far North

"Frigid," "snow-covered," "isolated," "barren," are the usual terms by which the average person describes the Far North. The Klondike gold rush—fortunes made and squandered overnight; Eskimos living in igloos, harpooning whales, and creeping slowly across the ice after polar bears or seals: this was the traditional north country, and it supposedly mothered a lusty brood. Time and the white man's civilization have changed much of this. The Eskimo frequently uses a high-powered rifle for hunting; the Indian's canoe may be driven by an outboard motor, and airplanes carry supplies and equipment into the remote mining camps, and carry the gold out. Thus, as civilization advances, the primitive life recedes into the most isolated regions.

Man's conquest of the North has not been uniform, however. In Alaska the coastal regions and Yukon Valley are most developed; in Canada, the upper Yukon, Mackenzie, and Slave river valleys and a widespread net of trading posts are the only important centers of white influence. Elsewhere the region is unexploited except by a small native population. The

rest of the subarctic must await the development of new pioneering techniques before its harsh environment is of value for white settlement.

Hunting and fishing are the principal industries, and furs and fish products are the major exports of the region. Mineral resources are common, but only precious minerals can stand the high cost of transportation to world markets. Likewise, transportation handicaps the lumber industry, for but little of the timber stand is good enough to justify the building of railways or other expensive transportation. These industries support only a very sparse population. Thus the Northwest Territory (area, 1,242,000 square miles) has a population of 7000 Eskimos, 4000 Indians, and less than 1000 whites.

The most important single environmental influence is climate, which affects and largely limits all human activity Climate, by regulating the length of the growing season and the quality of the soil, restricts agricultural development, and, by influencing transportation and working conditions, controls shipping and the exploitation of mineral and animal resources Because this region is near the Arctic Circle, winter temperatures are low, especially away from the ocean. The long arctic summer days cause almost equally extreme summer temperatures. Thus, in the Yukon territory of Canada, 75° below zero has been recorded in winter and 100° above zero in summer.

Contrary to popular impression, the snowfall is light. In fact, many areas suffer from aridity. When snow does fall, however, it is slow to melt and may cover the ground for from seven to nine months.

Summer conditions are almost unbelievable. The mercury soars and the land thaws quickly, although not to a great depth. Such extensive swamps are formed that mosquitoes and flies breed in huge numbers and are an even more serious menace than winter cold, blizzards, and the arctic wolf. While the growing season is short, agriculture is nevertheless possible where the soil permits. Only quick-maturing crops can be cultivated. One favorable factor is the great amount of sunshine during the short season. At the Arctic Circle, the sun shines from eighteen to twenty-four hours each day during the growing season.

Alaska. This possession, nearly one-fifth the size of the United States, was purchased from Russia in 1867. The price paid by the American Government was $7,200,000, a sum which most American citizens then believed was far in excess of its value. But, contrary to the impression of the times, Alaska was not entirely a desolate territory of ice, Eskimos, and polar bears. Its mines and fisheries have since produced more than

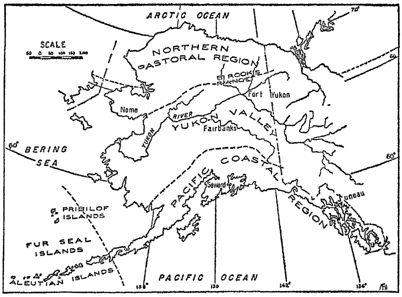


Figure 249. Regional map of Alaska.

a billion dollars' worth of goods, and its potentialities are almost untried Although it corresponds in latitude and area to Norway, Sweden, and Finland, it supports but 60,000 settlers compared with nearly 12,000,000 people in the Scandinavian countries.

The Pacific Coastal Region. This is almost a continuation of the Pacific Northwest of the United States and British Columbia. The seasons are about 5° to 10° cooler, and level land is much scarcer than in the Pacific Northwest. The principal resources are timber, fish, gold, copper, and water power; and the leading economic activities, lumbering, wood-pulp manufacturing, salmon-canning, and mining, are closely related to the resources.

As in Norway, the coast is fjorded and warm ocean currents keep its deeply indented harbors free from ice. Only peripheral position and the lack of labor prevent further industrial and commercial expansion. Minerals and water power are there to provide the bases for chemical and steel industries which have developed on similar sites in Norway and Sweden.

The Fur-seal Islands. This small region offers a fine example of what can be done to stop destructive exploitation of a resource. The Pribilof Islands have long been famous for the great number of fur seals that live on their shores and in the surrounding waters. Sailing vessels from the Pacific maritime nations visited the region to get as many pelts as they could. By 1911 the fur seal seemed doomed to extinction. Fortunately, the United States negotiated a treaty with Russia, Japan, and Canada, by which sealing was prohibited. In return, the United States agreed to slaughter about 25,000 male seals annually and divide the pelts among the signatory nations.

The Yukon Valley. Central Alaska is a huge region of rolling uplands and river valleys. Its resources

are largely undeveloped, in fact, almost unknown. Furs and gold are the only commercial products, but they are so valuable that they started a rapid although erratic development at the end of the nineteenth century. Steamer service was instituted on the Yukon and several of its tributaries, and two railways connected the Gulf of Alaska with the Yukon steamers. But since 1901 both the population and the gold production have declined.

Aside from possible undiscovered mineral resources, the pastoral industries offer the greatest future for the region. The severe climate, which restricts general farming, does not prevent the growth of barley, hay, and root crops, all of which may be stored for winter forage. Meat, cheese, hides, and such products are of high value in proportion to their bulk, and can often stand the cost of transport to distant markets. But there are also serious disadvantages. The animals must be housed during the long, severe winter; special breeds are necessary to fit the climate; insect pests are a danger to animals as well as an annoyance to man; and, finally, living conditions during the long dark arctic winter are hardly attractive.

The Northern Pastoral Region. A broad, low mountain area (the Brooks Range) separates the Yukon Valley from a bleaker region to the north. Except for the mineral area around Nome, the region is inhabited only by a sparse population of Eskimos and a very few missionaries and officials. Formerly the Eskimos lived by fishing, sealing, and by hunting the caribou, musk ox, rabbit, and arctic fox. The United States Government has altered this simple hunting economy by introducing the domesticated reindeer from Lapland. Today there are many reindeer ranches under Eskimo control. These animals provide a more certain source of food and skins than the wild animals; thus the danger of famine has been removed.

Minerals. The mineral resources of Alaska are many and widespread, but only precious metals have been much exploited. Coal and copper ore are known to be present in large amounts, while some iron, chromium, lead, zinc, tin, and tungsten deposits have been discovered. Transportation difficulties will undoubtedly prevent the exploitation of these minerals for some time, but when mineral prices justify exploitation, railways will be built. Already the government railroad from Seward to Fairbanks has made many coal and copper deposits accessible.

The Polar Icecaps. These deserts of ice seem about as valueless as any area that can be imagined; yet scientists have devoted much time, money, effort, and many lives to their exploration. There are several scientific reasons which justify this great effort and expense. First, each polar expedition adds something to our knowledge of polar weather, and thus to the complete picture of the earth's weather. It is thought that polar weather influences weather in the lower latitudes, thus information about it may eventually increase the accuracy of weather predictions elsewhere. Likewise, a knowledge of polar geology may help in the explanation of the geological history of the world as a whole; it may also uncover new mineral resources beneath the polar icecaps. Another reason is the possible use of the transpolar air route, which, being a great circle route, is shorter than many of the common intercontinental routes in the middle latitudes

QUESTIONS FOR DISCUSSION

1. Should the United States Government encourage the exploitation of Alaskan minerals?
2. The West and the Far North are both pioneering regions How are they alike and how are they different in their problems?
3. What are some recent polar discoveries? Are any practical results likely to develop from these discoveries?

CHAPTER 43

MEXICO, CENTRAL AMERICA, AND THE WEST INDIES

To THE south of the United States lies a chain of tropical and subtropical lands which practically surround the Caribbean Sea and the Gulf of Mexico. These lands are today largely under the business domination of Americans and Canadians, although their trade with Europe is still important. This area as a whole has unity in many of its major characteristics, although there is considerable variety in the details. Almost all of these lands are rugged and the moisture precipitated when the trade winds strike the highlands, adds to their productivity as well as brightens their scenic beauty. The trade winds give their shores a more comfortable climate than is possessed by most tropical areas, yet today, except in favored highland localities, the colored races predominate, and the white man occupies the land primarily by ownership and management rather than by permanent residence.

The trade-wind shores were the first part of the New World to be occupied by Europeans. In the days of sailing vessels, these lands, reached from Europe by sailing *with* the northeast trades, were naturally settled before the more northern colonies, including Virginia and Massachusetts, which could be reached directly only by sailing *against* the prevailing westerlies. Sailing vessels often used a triangular route (London, West Indies, Philadelphia, London) in making the round trip from Europe to take advantage of the favorable winds.

The trade-wind shores had an additional advantage over the northern colonies. The former were suited to the production of much-desired tropical products —sugar, rum, cacao, and spices—while, with a few exceptions, the northern colonies duplicated European production. The great demand for tropical products caused almost all the European nations which bordered on the Atlantic to enter into the trade and colonization of the West Indies. Spain, Portugal, England, France, Holland, and Denmark all obtained a foothold, and their ships carried on a busy trade which was so profitable that it flourished in spite of heavy losses from piracy.

A few of the plants which supplied the tremendous demand for tropical products were indigenous in the New World, but most of them (sugar cane, banana, coconut, coffee, and many spices) were imported from the tropics of the Old World. Since these plants did not grow wild, it became necessary to establish plantations. For these, a cheap labor supply was necessary. The most obvious source was the American Indian, but it was soon discovered that the Indian had a will of his own and would not make a satisfactory slave. Convicts and political prisoners were also sent to the plantations, but these either died of disease or tended to rise to the managerial class. Next, the plantation owners turned to Africa and from its west coast imported the ancestors of most of the present population of the region.

Besides the Negroes, a group of more or less permanent white settlers developed. Some of these were royal favorites who were granted large estates, others went to seek their fortune or to avoid bankruptcy or other disgrace at home; many were convicts, or persons kidnapped to serve as labor on the plantations. During the last century, the white element has declined in numbers and importance. The supply of convicts and immigrants from Europe has all but disappeared. Many of the white settlers or their descendants moved north to the United States and Canada; others made their fortunes and returned to Europe. Many lost their identity in Indian and Negro groups and their children make up the mulatto and mestizo [1] population.

The development of the humanitarian spirit, especially in Europe, led to the gradual abolition of slavery during the nineteenth century. At first, this change greatly decreased productivity, but the planters soon discovered ways of partially overcoming the laziness of the colored population. Peonage (forced labor to pay a debt owed to the planter) and payment per task rather than per day were among the methods used. In Trinidad and the near-by Guiana colonies,

[1] A *mestizo* is a person of mixed white and native Indian blood.

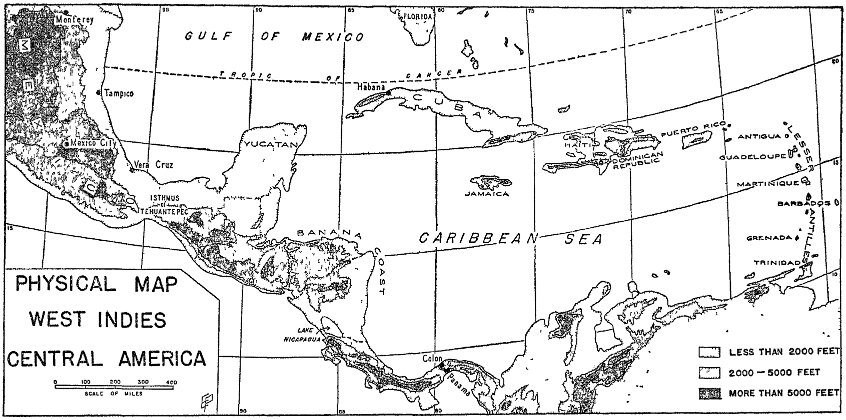


Figure 250. For this area a physical map is better than a regional map since there is great variety in environments according to altitude and exposure to the trade winds.

contract coolie labor was imported from India, Java, and China.

Central America

Most Central American countries include three regions. (1) a forested eastern slope; (2) the uplands which are the structural backbone of the Central American isthmus; and (3) a drier Pacific slope. In Salvador, the forested eastern slope is lacking, in British Honduras, the other two regions are lacking. In Panama, the central highlands do not rise to any considerable elevations, and the tropical forest which characterizes the eastern slope extends across the Isthmus.

The Eastern Slope. The shores of this region were once known only by the unattractive name of "Mosquito Coast." The trade winds blow steadily against these shores from November to April and bring rain and refreshing breezes. The northward movement of the equatorial rain belt also brings heavy rains during the summer Forests, swamps, mosquitoes, and leached soils are the region's response to this heavy rainfall. For centuries the region was almost unused except by nomadic Indian farmers and by a few woodcutters who sought mahogany, logwood, and chicle.

The Caribbean coast from Yucatan to Colombia is now known by the more attractive name of "the Banana Coast." At intervals along the shore the United Fruit Company (and several smaller British and American companies) have utilized the fertile delta soils and converted the jungle into prosperous fruit plantations. Most of the labor consists of Negroes from the British West Indies; thus English, rather than Spanish, is the predominant language. The change of parts of this coast from Mosquito Coast to Banana Coast represents a very rapid and thorough transformation by one of the most highly organized industries.

In setting up a banana plantation, the first step is to obtain from the government or private interests a concession of thousands of acres of good accessible land One of the company's ships is then equipped with the necessary tools and supplies and carries a passenger list of managers, engineers, accountants, timekeepers and hundreds of Negro laborers. In fact, the materials and population for the proposed port and adjacent plantations are shipped as one lot. Upon arrival, one part of the force clears the jungle from the town site; establishes proper drainage and sanitation; builds a store, a hospital, and rows of wooden houses with corrugated iron roofs Another force builds a railway through the proposed banana area; a third group starts to work preparing the land for the banana trees.

The land selected for bananas must have seventy-five inches or more of rainfall well distributed throughout the year. On such land the workers cut down the undergrowth of the forest, using axes and

machetes. Drainage ditches are dug to remove any surplus water. The land is then ready for planting. Stakes are set out at intervals and at each stake a hole is dug, within which the bud of an underground shoot from a banana stalk is planted Before the banana plant appears above the ground, the large trees of the native forest are felled and left as they fall The shoots now grow up under the protection of a mulch of forest treetops. A few months later the plantation must be cleaned out. Negroes cut their way through the tangle of branches and chop away enough of the vegetation to insure that each banana shoot receives sunshine. Unwanted young trees are also destroyed at this time. This weeding process must be repeated several times a year as long as the plantation lasts. The trunks of the large trees decay rapidly in the tropical humidity, so that in a year there is little left but the banana trees and the weeds which must be constantly kept down by the machete.

Fifteen months later the banana plants are fifteen to thirty feet high. The first bunches are ready to be cut. The drenched land is too soft for a wagon, but a mule can haul a light tramcar over the tracks which have been laid through the plantation every few hundred yards. The cutting of the banana starts when the plantation receives a radiogram that a steamer is soon to call at the port. Work starts at daybreak and soon the tram lines and the railways are delivering bunches of half-ripe bananas to the wharf. Endless belt conveyors load them on the steamship, where they are placed in refrigerated compartments. After three or four days' sailing the steamer arrives at New Orleans or some other American port where more conveyors transfer the cargo to refrigerator cars. Many inspections take place en route to eliminate bruised and spoiled fruit. Speed and care are necessary throughout if the bananas are to reach the market at the right time and in good condition.

The fruit companies have also developed numerous side lines, such as wireless service, passenger service, and the tourist trade. But the influence of these companies extends only over a small part of the eastern shores, for only the rich soils of the deltas and river banks are sufficiently fertile for profitable plantations. Except along a few through routes, the rest of the region remains, as in the past, an unhealthy little-exploited tropical forest.

The Central Plateaus and Mountains. The low coastal areas are known to the people of Latin America as *tierra caliente* (hot land). Above 3000 feet the climate is enough cooler to justify the term *tierra templada* (temperate land), which is where most of the white population lives. Above about 6000 feet is the *tierra fria* (cold land), where wheat, barley, and potatoes replace the coffee, corn, and beans of the *tierra templada*.

Most of the plateau is in the *tierra templada*. It consists of rolling and hilly land with occasional volcanic peaks and ranges rising abruptly from the general level These mountains with their active volcanoes indicate the ever-present danger of eruption and earthquake. They are also responsible for the fertile volcanic soil which makes possible the principal money crop of the plateau. coffee. Most of the coffee is grown on large plantations by local white planters employing half-breed and Indian labor. The small farmers usually occupy the hillier land and use most of it for corn and beans, the principal food crops. They also raise a few cattle (for hides, labor, and local meat supply) and some coffee, since the latter can always be exchanged for the few tools and articles of clothing which must be imported from abroad.

The Pacific Slopes. This region gets the trade winds only after they have crossed the moisture-removing mountains. Consequently it receives rainfall only when the equatorial rain belt is north of the equator (April to November). This alternating wet-and-dry climate reduces the number of trees and increases the proportion of grassland. Cattle raising is therefore important. The main crop is sugar, although some coffee is grown on the higher land intermediate between the coastal lowlands and the plateau.

Since the Pacific lowland strip is narrower and healthier than the swampy, densely forested eastern lowland, most of the main routes between the plateau and the sea terminate on the Pacific On the whole, the three regions are, economically, surprisingly independent. The eastern coast is under the economic domination of the banana companies, the plateau is under the control of the coffee planters, while the Pacific slope has been but poorly developed by its Indian and half-caste population.

The Central American Countries. The eight political units of Central America contain, together, less than 7,000,000 people. For the most part, these countries compete with one another, for their products are the same. However, each has individual characteristics, due partly to social causes and partly to the proportion of each type of environment in the particular country. For example, Costa Rica, generally considered the most progressive republic, has most of its land on the plateau, and most of its farmlands have the fertile volcanic soil favorable to coffee. On the other hand, British Honduras and Panama are mostly

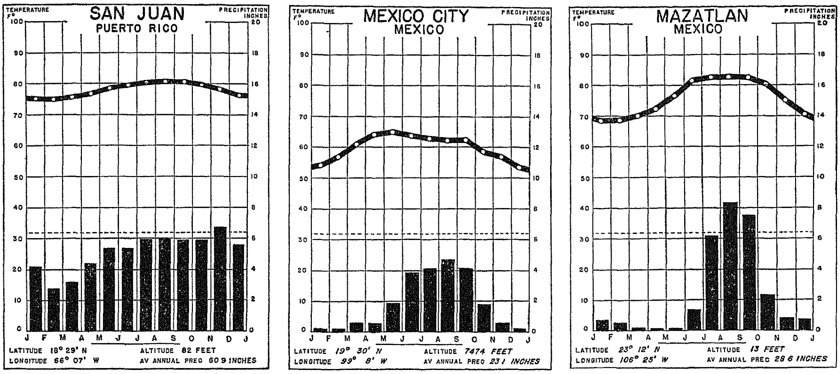


Figure 251. Climates similar to those shown on these charts occur in most of the political units of Caribbean America. How may this fact be explained?

in the trade-wind-shores region and produce but little coffee. Guatemala, the most populous republic, spreads across the continent from the Pacific slopes to the Banana Coast, but most of its population is on the plateau, and coffee, therefore, makes up six-sevenths of its exports. Each Central American country produces enough of its neighbors' products for home consumption, hence there is very little trade among the eight political units.

Central America and Interoceanic Routes. Since the sixteenth century the Isthmus of Panama has been an important route in interoceanic trade. The construction of the Panama Railroad about the middle of the nineteenth century greatly increased its importance as a passenger and freight route The opening of the Panama Canal (1914) gave it almost a monopoly on the water trade between eastern and western North America.

The growth of the trade of the Pacific coasts of the Americas may overcrowd the Panama route. Many alternative Central American routes exist, including three rail routes. The above railroads (across southern Mexico, Guatemala, and Costa Rica) carry little through traffic and are not expected to develop along these lines. There are, also, two potential canal routes. The Nicaraguan plateau is unusually low and a large part of it is occupied by the extensive Lake Nicaragua. This lake is connected by the San Juan River with the Caribbean Sea and a twenty-mile canal would connect it with the Pacific. The central plateau is also fairly low and narrow (one hundred and fifty miles) at the Isthmus of Tehuantepec in southern Mexico. Both of these possible canal routes would shorten the voyage from New York to San Francisco as compared with the Panama route.

QUESTIONS FOR DISCUSSION

1. How does each of the three regions of Central America compare with your state as a place for human activity?
2. Is position a handicap to the central plateau? Would it be a disadvantage if the moist trade-wind shores were on the west coast instead of the east coast?
3. Look up in some history book several cases of American military intervention in Central America and Mexico. Was there any geographic basis for the intervention in each case?

Mexico

Mexico in both position and nature is intermediate between the United States and Central America. The three regions of Central America continue into southern Mexico, and northern Mexico is, physically, but a continuation of the regions typical of western and southern United States [1] The minerals, irrigation, and grazing of the Basins and Ranges of Arizona and New Mexico are duplicated in kind, although not in degree of development, in northern and central Mexico. Likewise, the mountainous areas and the Coastal Plain continue into temperate Mexico.

The most distinctive part of Mexico is the Central Plateau which supports nearly half the population of 17,000,000. This area is a mass of complex rocks,

[1] See Chapters 41 and 42.

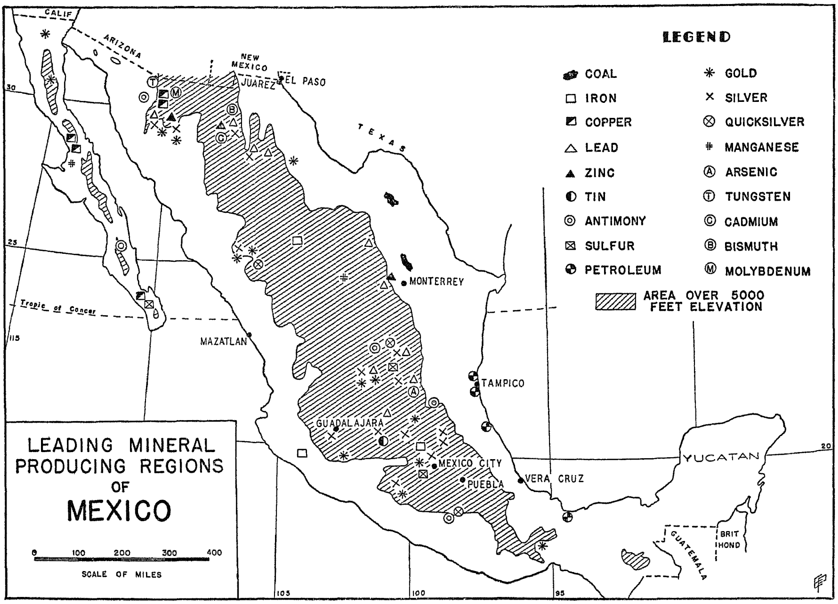


Figure 252

pierced with igneous intrusions, folded and faulted, and in places capped by lava flows and volcanic cones Like the Columbia Plateau, it has rich soils and moderate rainfall which can often be supplied when necessary by irrigation waters from the adjacent mountains. The plateau is a great storehouse of mineral wealth, including precious metals, lead, and copper, whose exploitation is of interest to foreigners and Mexicans of the capitalist class. The majority of the population, however, is interested in the agricultural resources which produce quantities of corn, beans, wheat, cattle, and vegetables. In this rich mineral and agricultural area is situated Mexico City, a metropolis of nearly 1,000,000 people, and the cultural, political, financial, and industrial center of the republic.

West of the Central Plateau the Western Cordillera runs roughly parallel to the Pacific Coast. It is important as a barrier and as a source of minerals. Below it is the Pacific Coastal Plain, an arid or semiarid region of little value except for ranching.

To the east a rugged escarpment separates the Central Plateau from the Coastal Plain This plain varies greatly in resources and climate from north to south. The semiarid region in the north is important around Tampico because of the huge pools of petroleum underlying the plain. Further south, around Vera Cruz, the moist, tropical climate permits the growth of cacao, vanilla beans, coffee, and bananas. In Yucatan, the lowlands are semiarid, partly because of the porous nature of the underlying limestone, and provide optimum conditions for the agave plant, from which the rope fiber, sisal, is obtained.

Most of northern Mexico is a plateau about 5000 feet in altitude. Like the Great Basin of the United States, this region is arid or semiarid, has interior drainage, and is economically active in mining, ranching, and irrigation farming. In the mountains to the east of the plateau is Monterey, the second industrial center of Mexico. Coal and iron ore from near by plus a high tariff on imported iron and steel goods have enabled this city to develop a small steel industry.

The National Economy of Mexico. The Mexico of the international trader is entirely different from the Mexico of the average Mexican. The trader considers Mexico as a storehouse of valuable minerals. Its mountains are especially rich in silver, lead, copper, and gold, while iron, mercury, sulphur, bismuth, tin, and tungsten are also present. Mexico is the world's leading silver producer and is among the leaders in the production of lead, copper, and petroleum.

To the average Mexican, Mexico is a pleasant land where life requires little and that little is easily obtained. Corn, beans, peppers, and, occasionally, some meat from the country's many ranches provide an adequate, if monotonous, diet. Four-fifths of the people are Indians or mestizos, and to these people, accustomed as they are to low standards of living, the land seems good if only the white planters and the foreigners would let them alone. The country has many raw materials for industrialization and a large area with stimulating climate, but so far industry has developed only on a small scale and mostly under foreign control in such cities as Tampico, Monterey, and Mexico City

QUESTIONS FOR DISCUSSION

1. Look up in the *Foreign Commerce Yearbook* the exports of Mexico. What per cent of the total exports consists of minerals? What generalizations can you make about the exports of Mexico?
2. What type of clothing would you carry if you traveled to Mexico City via Vera Cruz? via Monterey?
3. Along what lines do you think the future economic development of Mexico will proceed?

The West Indies

This long chain of islands is made up of two major types of rock—limestone and volcanic. The limestone formation, which generally forms flat or rolling topography, extends (Fig. 250) from Yucatan through most of Cuba, the Bahamas, the Virgin Islands, Antigua, eastern Guadeloupe, Barbados, Tobago, and part of Trinidad Within this arc, to the south and east, volcanic rocks make up the rugged mountainous backbone of Jamaica, eastern Cuba, Haiti, Puerto Rico, St. Kitts, Dominica, Martinique, Guadeloupe, St. Lucia, St. Vincent, Grenada, and Trinidad. Both of these rock formations produce a more fertile soil than is usual in the tropics. Almost every part of the islands is exposed to the trade winds which bring rain to the windward slopes and moderate the sensible temperatures.

Like Central America, the West Indies consist of moist trade-wind shores, central plateaus and mountains, and a drier leeward slope. These regions are found on most of the larger islands and on many of the smaller, more rugged islands. Unlike Central America, the most developed parts of the West Indies are the lowlands rather than the upland areas. Easy accessibility to the coast from most parts of even the larger islands and generally good soil have made it possible to develop most of the lowlands to the same extent that the fruit companies have developed limited alluvial areas in Central America.

The dense population of the West Indies has been supported by specialized production for world markets rather than by the largely self-sufficient agriculture

Figure 253

CUBA—EXPORTS OF PRINCIPAL COMMODITIES

(in million dollars)

Commodity	*Value 1913*	*Per cent of total 1913*	*Value 1920*	*Value 1928*	*Value 1932*	*Value 1934*	*Value 1937*	*Per cent of total 1937*
Raw Sugar	115	70.0	724	199	40	63	105	56.4
Refined Sugar	0	0.0	0	16	14	11	22	11.8
Molasses	1	0.7	8	9	3	6	18	9.9
Tobacco products	35	21.0	48	39	13	14	15	8.5
Iron Ore	4	2.7	6	0.1	0.1	1	1	0.6
Vegetables and fruit	3	1.7	3	3	3	*	5	2.7
Spirits	1	0.3	*	1	1	6	2	1.1
Other	5	3.6	5	10.9	6.9	7	16	9.1
Total Exports	164	100.0	794	278	81	108	186	100.0

* Not given separately

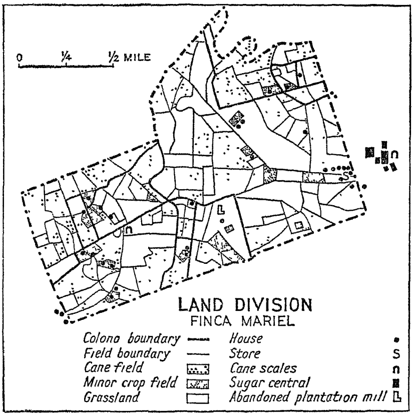


Figure 254 This typical sugar plantation is divided into *colonas* of from 10 to 450 acres in area These units are rented to tenant farmers who sell their cane to the sugar central The grassland serves as pasture for the oxen, horses, and mules so necessary as draft and riding animals. The sugar is exported through a port just off the map to the north (From "Geography of a Sugar District: Mariel, Cuba," by Robert S Platt, *Geographical Review*, October, 1929.)

practiced by the bulk of the Central American farmers. This is strikingly shown by a comparison of Cuba and Guatemala, two countries about equal in area. Cuba's foreign trade has been from nine to thirty-five times as high as Guatemala's. Cuba exports sugar and imports almost everything else. In good years, Cuba buys one-fourth of all the products which the United States sells to *all* Latin America. Such dependence on foreign trade permits greater prosperity, but it also involves grave risks due to a possible price decline or market shrinkage in the few commodities upon which the West Indian planter depends.

Cuba. Cuba has close to the optimum conditions for producing sugar cane and could, if its land were fully utilized, supply most of the world's sugar. Much of the island has fertile limestone soil, a large part of which has never been tilled. Such extensive resources permit virgin soils to be used as the old lands become exhausted, and, once the crop is established, annual harvests may be reaped without replanting. The land is level enough to permit the use of machinery and large-scale farming methods. Furthermore, Cuba can tap a large supply of American capital and is within one hundred miles of the world's largest sugar-consuming country. With all its advantages, Cuba is nevertheless in the dangerous situation of having "all its eggs in one basket." The sugar industry is the backbone of the island's economy. Other activities of some importance are the raising of tobacco and winter vegetables, cigar making, the tourist industry, and the export of iron, copper, and manganese ore. These minor industries are far from sufficient to balance the fluctuations in trade caused by the rise and fall of sugar prices, as can be seen from the table, Fig. 253. The Cuban government has tried crop-restriction schemes, encouraged diversification of agriculture and the development of simple manufacturing industries, such as sugar refining and textiles, but these efforts have solved only a small fraction of the problem.

Other Greater Antilles. The rugged islands of Jamaica, Puerto Rico, and Haiti are much more diversified than Cuba in resources and development. All produce sugar, coffee, tobacco, and tropical fruits. Consequently they are not as hard hit as Cuba by the uncertainties of the sugar market.

The densely populated island of Puerto Rico has the advantage of being within the American tariff wall. This and its rich volcanic and limestone soils account for its high degree of development.

Jamaica resembles Puerto Rico in climate, interior mountains, and rich coastal lowlands. For many of its products it has a protected market within the British Empire, though its principal export, the banana, produced near the northeastern coast, was until recently shipped largely to the United States.

Haiti is by far the largest, most rugged, and least developed of the three islands. It is divided into two republics: Haiti and the Dominican Republic. Until recently, the island was under American control.

Barbados and Grenada. These two British islands may be taken as representative of the many small islands which make up the Lesser Antilles. Barbados (166 square miles) is a low, coral limestone island with moderate rainfall; Grenada (133 square miles) is a rugged, volcanic island with from heavy to moderate rainfall depending on the altitude and exposure to the trade winds. In 1885 both islands were sugar producers and were faced by bankruptcy because of falling sugar prices.

Grenada met its problem by shifting to other crops. Cacao and nutmegs were introduced at first on the hitherto unused slopes and, later, replaced sugar in many of the valleys. By 1900, Grenada had become a sugar importer.

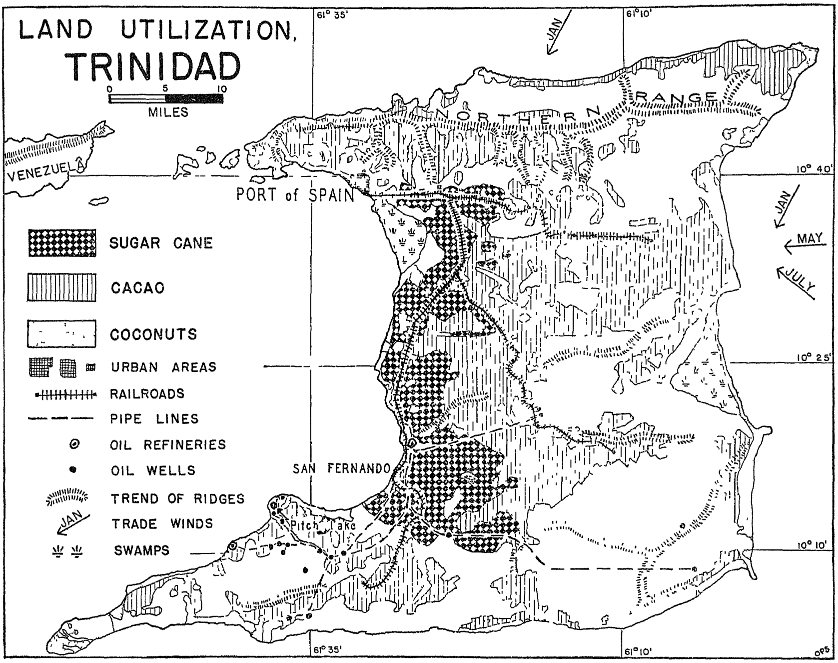


Figure 255 Where is the heaviest rainfall on the island? Why are the railroads on the western side?

Barbados has a less versatile environment. Sugar was apparently the only source of income. The Barbadian government improved the sugar factories and developed more productive varieties of sugar, which have since been adopted throughout the world. Instead of competing with Cuba, Barbadian sugar factories turned their cane into high-grade molasses which was sold in the Canadian market.

Trinidad. This British island, slightly smaller than Delaware, contains an unusual variety of environments, peoples, and industries for such a small area. The people are mostly Negroes and Hindus with a sprinkling of Chinese and several European nationalities. Trinidad is best known for its oil and asphalt, which make up nearly half its exports. More important from the point of view of the number employed are the cacao plantations which are found in the moister two-thirds of the island and the sugar plantations which occupy the savanna lands. Trinidad also obtains some revenue from transshipping goods whose final destination is Venezuela, the Guianas, or the Lesser Antilles.

QUESTIONS FOR DISCUSSION

1. How does Cuba compare with Trinidad in its economic life? What advantages has each?
2. What economic problems would arise if Puerto Rico became independent?

REVIEW QUESTIONS ON CHAPTERS 34 TO 43

1. What is a region? On an outline map of North America, sketch in roughly the regions and subregions discussed in these chapters What unifying factors are the bases for each region?
2. What products does each region export? What kinds of imports would you expect in each region?

CHAPTER 44

SOUTH AMERICA

THOUGH the settlement of South America was well under way by 1550, and Brazil was an important exporter of sugar before the settlement of Plymouth by the English, South America has developed but slowly and has been far outdistanced in economic progress by North America. Why is it that South America has at the most probably not more than 82,000,000 inhabitants, while North America has 180,000,000? Why, with one-seventh of the land area of the earth, has South America only one-thirtieth of the world's population? Why has important business developed only in a number of widely scattered regions, leaving tremendous tracts of land almost unexploited? No single factor can explain the retarded development of South America. As in all geographic problems, the explanation must include not only the environment, but historical accident and the number, abilities, and ambitions of the people who inhabit it.

Human Factors in the Development of South America. When South America was first explored by the Spaniards, they found in it a great variety of Indian cultures. In the far south were the extremely primitive Indians of Tierra del Fuego; northward were the warlike and advanced Araucanians of Chile and the tall warlike hunters of Patagonia. In the tropical forests and savannas were tribes of hunters and primitive farmers, while the Andean highlands were under the well-organized government of the Incas who ruled many less-civilized tribes.

The Conquest resulted in an imposition of a thin veneer of Spanish civilization upon an old, well-established Indian regime. The early Spanish conquistadors were seeking gold, silver, or other riches, rather than homes. Unlike the settlers of North America, they rarely brought their families. Widespread intermarriage with the Indian women resulted in a large mixed race and a caste social structure based on wealth and color. Numerous Negro slaves were brought into northeastern South America and these further complicated the racial mixture.

During the colonial period, restrictions on production and immigration were numerous. The aim of the home governments was to obtain wealth by exploiting the natives, not to develop the country as a homeland. Industries that might compete with Spanish industries (for example, the wine industry) were forbidden. For many years all commerce, even from Argentina, was compelled to go by the way of the Isthmus of Panama—a requirement which made traffic in cheap, heavy materials almost impossible. A large group of colored and mixed peoples who owned little property and who had a very low standard of living, supported in luxury a small number of Spanish and Portuguese soldiers, officials, and estate owners.

After the South American countries obtained their independence (1821-29), there were fifty years or more of political instability and, in many of the countries, political conditions are still rather turbulent. Such unstable governmental conditions in South America, contrasted with conditions in the United States, retarded the investment of capital in the South American republics, and led immigrants to choose the United States as long as immigration restrictions were lacking and free land was still available. Sizable immigration has occurred only in recent decades and only in certain favored areas—especially Argentina, southern Brazil, and Chile.

During the nineteenth century South America earned the reputation of being a very unhealthful continent. Although the ravages of some diseases have been greatly reduced and the effects of others appreciably overcome in the tropical areas, constant efforts are still necessary to combat malaria, yellow fever, hookworm, and dysentery Much has been done through sanitary engineering in the more active commercial areas, but disease is still rampant in the sparsely settled parts of the tropics.

The Environment and the Development of South America

The position of South America is poor compared with North America. Its largest area lies within the tropics, and its most advanced area is in the south

temperate lands, far from the principal world markets. The shape of South America is roughly triangular, but the widest part of the triangle is in the equatorial rainforest. The coast line is fairly regular, and good harbors are lacking except for a few on the east coast. Likewise, deep indentations which are useful in penetrating the interior are absent.

Relief and Minerals. In many respects the relief of South America resembles that of North America, although there are also many contrasts. In the western part of each is a high, young cordillera with high plateaus, but the ascent to the Andean system from both sea and plains is usually much steeper than in North America. Both continents have older, lower mountains near the Atlantic In North America the Laurentian Shield and Appalachians are separated by the St. Lawrence Valley; in South America the Guiana and Brazilian highlands are separated by the Lower Amazon Valley. Both continents have great lowland areas between the high western mountains and the lower eastern highlands, but climatic conditions are so different that the Mississippi Valley but slightly resembles the Paraná, Amazon, and Orinoco valleys.

As in North America, the western cordillera of South America is highly mineralized, consequently mineral products have always been of great economic importance to the Andean countries. The central plains, so far as they are explored, contain no widespread mineral deposits comparable to the oil and coal found in the analogous region of North America. The Brazilian and Guiana highlands are rich in minerals such as iron, gold, and diamonds, but lack the coal which makes the Appalachians so important to North American industries. As a whole, South America is well supplied with all minerals except coal. Chile has the only important coal deposits, but even this coal is not suitable for coking. The lack of this fuel is partly compensated for by the presence of great water power and oil resources.

The Andean mountain system forms a border of high young mountains almost parallel to the coast from Cape Horn to the Orinoco delta. It may be divided into three subdivisions, each having its characteristic influence. The Southern Andes rise from the sea at Cape Horn, but form no serious barrier for nearly a thousand miles because of deep valleys and passes cut into them by glaciation. Then, for another thousand miles, they form a narrow barrier range between the most progressive parts of Argentina and Chile. Throughout, the southern Andes are almost uninhabited, although in the future they may be valuable because of their minerals, forests, and striking scenery.

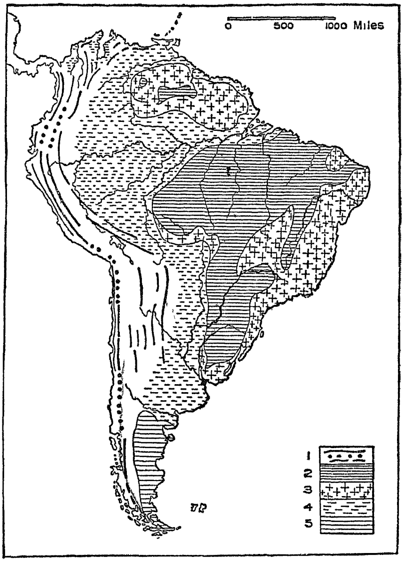


Figure 256. The structure of South America. 1. The Andes (dots represent volcanoes); 2 Unfolded sedimentary rocks; 3 Metamorphic and igneous rocks of the Guiana and Brazilian highlands; 4 Alluvial plains; 5. Plateau of Patagonia. (From Newbigin, *A New Regional Geography of the World,* Harcourt, Brace, New York)

Near the Tropic of Capricorn, the Andes divide into two ranges which inclose a high plateau (11,000 to 14,000 feet in elevation) known as the "Altiplano" This Central Andean area is the richest mineral area and contains important deposits of copper, tin, silver, lead, and vanadium as well as considerable gold, bismuth, tungsten, molybdenum, mercury, and zinc. Other rich ore deposits may also be discovered, for the region is incompletely explored.

North of Peru, the Andes become lower and less rugged. The populous plateaus which adjoin many of the higher ranges are temperate or subtropical in climate and are much more productive agriculturally than the barren Altiplano.

Climate. The climate of South America is largely tropical and subtropical. Only a small part of the continent is temperate and much of this area is handi-

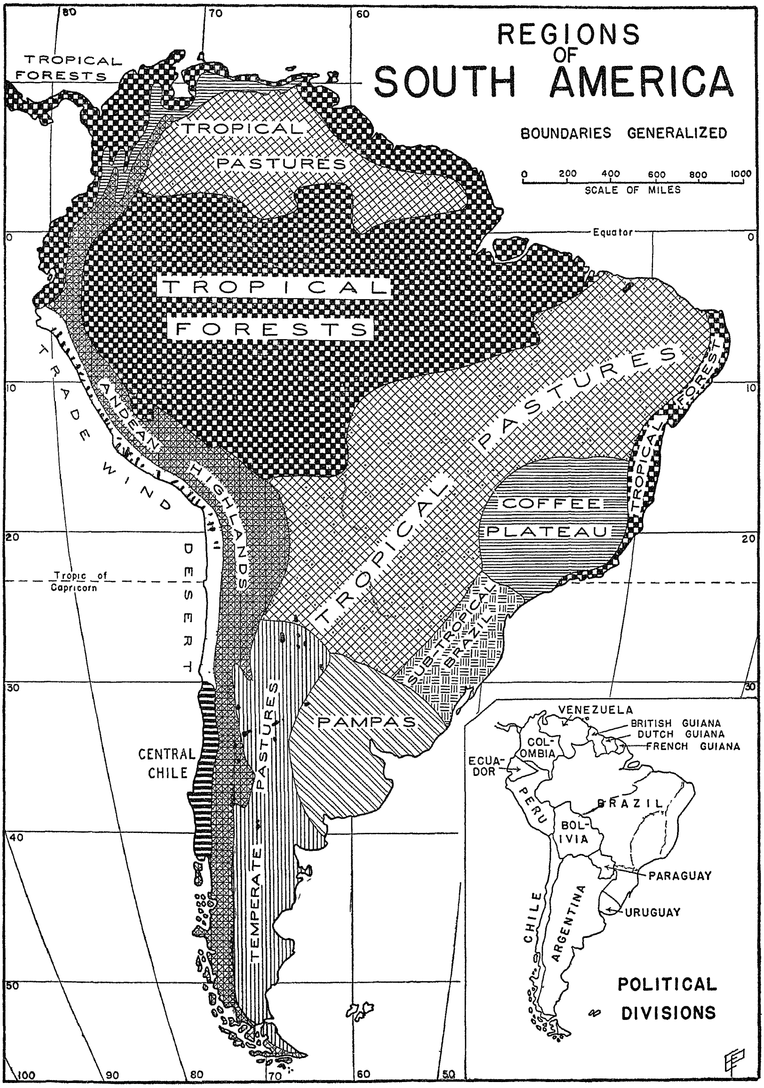


Figure 257. The small black areas in the Trade-wind Desert and Temperate Pastures are oases.

capped by aridity or rugged relief. Most of the intensive economic development in South America has occurred in favored climatic islands such as the Pampas of Argentina, the Mediterranean region of Chile, and tropical highland areas.

Economic Development. Economic life in South America, at present, has developed in a few major regions and in numerous isolated centers. Each center represents some combination of favorable environmental conditions which encourages the production of goods for the foreign market Usually, each area specializes in but one or two major products which enter international trade. With a very few exceptions, these products are foodstuffs or raw materials. Manufacturing has scarcely developed beyond the small home-industry stage. Hence the trade of South America consists largely of the export of raw materials and the import of manufactured goods.

The trade of each South American center is largely with the industrialized regions of Europe and North America, rather than with its continental neighbors. Trade routes connect each country with Europe and North America; routes connecting neighboring countries are in existence only because they are parts of routes whose termini are outside South America. For example, there is frequent steamship communication between Argentina and Brazil, but this is because ships from Buenos Aires to New York or Liverpool stop at Brazilian ports en route. On the whole, South American development has been in limited, separated hinterlands of the various ports.

Since each economic center of South America is dependent on a few key products which are sold in the world market, any world factor that disturbs the market for one of these products is likely to cause serious economic troubles in the South American production center. Often these economic difficulties have serious political repercussions, such as revolutionary movements and local attempts at secession. The coffee and rubber regions of Brazil, the nitrate section of Chile, the oil section of Venezuela, are but a few of the areas which are largely dependent on one product, a decline in the price of which will cause widespread dissatisfaction.

It must be remembered that, in addition to these commercial products, there are a large number of sustenance industries which supply a local market. The life of many peasants revolves around this provincial center and is only indirectly concerned with the world of big business. The products they use are corn, beans, potatoes, cassava, tropical fruits, peasant clothing, crude tools, and a few foreign imports such as cotton cloth. All but the last are produced in or near the peasant's hut As long as the staple products are available, the peasant is little disturbed by political and economic movements which are manipulated by landlords, mine owners, students, and the small professional class.

QUESTIONS FOR DISCUSSION

1. Compare North America and South America as to relief, climate, and position
2. Suppose North America had been settled entirely under the control of Spain and Portugal, how do you think its development would differ from the actual development?
3. If South America were controlled by England, how far might it develop manufacturing? What kinds of manufacturing would be impossible for environmental reasons?

Argentina and Uruguay

Argentina is the most progressive nation of Latin America. Its capital, Buenos Aires, is, except for Paris, the largest Latin city in the world. Within it dwell one-fifth of Argentina's 11,000,000 people. The largest railway net in South America connects Buenos Aires with a rich and varied hinterland. The products are, however, largely agricultural Some minerals are available but they are far from adequate for manufacturing The oil fields of Patagonia and northwestern Argentina are unable to supply the present Argentine demand. Some coal is present in the Patagonian slopes of the Andes, but it is cheaper to import the better-grade English coal Manufacturing is limited to two types: (1) the preparation of Argentine crop and animal products for shipment, (2) the manufacture of simple articles, such as shoes and textiles, for the local market. For the second type Argentine leather, wool, flax, and cotton supply raw materials

The Pampas. The economic heart of Argentina is an extremely flat plain which occupies most of the land within a radius of 250 miles of Buenos Aires. This area is named the Pampas or La Pampa after Spanish words meaning *plains* or *the plain*. Originally covered with a thick growth of grass, much of the area is now planted with crops or artificial pasture and is devoted to a moderately intensive system of grain farming and stock raising The climate is mild with moist, hot summers and less moist, cool winters. The weather is never so severe as to prohibit outdoor grazing, and it is therefore unnecessary to store large quantities of fodder for winter use as in the Corn Belt of the United States. The soils, roughly similar to the prairie soils of the United States, are

rich and free from stones and yield large harvests with but small application of labor.

The early development of the region was largely pastoral. Merino sheep were raised for their wool and cattle for their hides. The land was divided into large estates (*estancias*) and only a small part of its assets was utilized. Similar conditions are still found in neighboring Uruguay where high-grade wool sheep and beef cattle occupy areas well suited to more intensive activities.

The development of fast ocean transportation and refrigeration has transformed this region. From Buenos Aires, a network of railroads covers the Pampas. Wool sheep have been displaced by mutton sheep, and the tough colonial cattle have been pushed out by high-grade beef cattle. The pastures are now carefully fenced in and tended. Much of the area is devoted to the raising of alfalfa—a rapid-growing legume which is almost an ideal food for meat animals (page 164)

Farming has developed in those areas having the best soil and moisture conditions. Adjacent to Buenos Aires is the truck-farming and dairying region To the south and west of Buenos Aires a crescent-shaped area, extending to the wheat-exporting port of Bahía Blanca, is used for raising winter wheat by modern machine methods. Northwest of Buenos Aires (around the important river port of Rosario) is a corn-producing area with humid climate and exceptionally good soil. Although swine are raised here, lack of labor and the presence of animal diseases have limited the production of pork. Hence, much of the corn is exported as grain rather than fed to animals. Flax is also grown in the corn area, but, due to lack of labor needed to extract the fiber, only the seed is exported (for use in linseed oil).

The wealth of the Pampas is partly offset by unfavorable physical and social conditions. Drought is common, especially in the west. Streams are rare, for most of the rain is absorbed by the porous soil, and windmills must be used to pump sufficient well water for the flocks and herds. Plagues of locusts are also frequent and have been combated at tremendous expense with only partial success. Another handicap is the system of land ownership which keeps the land in units too large for efficient farming. Fertile farmlands are often used for pasture, because landlords prefer to continue the familiar stock raising At the same time, immigrants who wish to buy small farms find that the only land for sale is inferior farmland, better suited for pasture. Farm wages are low but at harvest time labor is scarce and peasants from Spain, Italy, and Brazil often find it worth while to seek temporary employment in Argentina.

Uruguay. Although it is the smallest country in South America, Uruguay is one of the most prosperous and progressive Latin American countries. Its grassy lands are level in the south and east but become rolling toward the northwest. Except for a narrow farming region along the Rio de la Plata, the whole country is occupied by well-kept sheep and cattle ranches. Animal products make up four-fifths of the exports.

Temperate Pasture Lands. Isolation, cool temperatures, and aridity limit most of this region to one industry—the raising of wool sheep. Physical conditions vary considerably throughout the region, but the human adjustment is usually but a change in the number of sheep per square mile. The greatest sheep population is found on the humid lands around the Strait of Magellan. Here, cool temperatures throughout the year, strong winds, and shallow soils discourage the growth of plants other than grasses. In spite of the moderate latitude and high humidity, agriculture is almost impossible.

The shepherds of southern Patagonia immigrated from the sheep-raising areas of northwestern Europe, especially Scotland, Wales, England, and Germany. With them they brought mutton and dual-purpose varieties of sheep Today sheep such as the Romney Marsh (an English breed) and crossbreeds have largely replaced the once universal Merino wool sheep. Frequent ship service and the establishment of refrigerating plants have made it possible to start an important frozen-mutton export.

North of 50° S. rainfall lessens because the higher Andes cause a deeper rain shadow. However, much of the land is a plateau whose altitude reduces both temperature and evaporation. Thus, a fairly good grass cover is maintained even where the rainfall is less than ten inches. North and east of the plateau, the vegetation becomes desert-like, and poor shrubby vegetation replaces grass. Merino sheep become dominant as better grasslands disappear, and, in the poorest areas, goats replace them.

North of 42° S., agriculture is possible where there is adequate water for irrigation. The warmer conditions, as well as the poorer forage, encourage the replacement of sheep by goats and range cattle

Within the northern half of the Temperate Pasture Lands are numerous small but important oases, watered by streams from the mountains. These oases perform an important economic function for Argentina, as they supplement her temperate agriculture with

subtropical crops. The oases of Córdoba and Mendoza produce grapes and other fruits and vegetables, largely for the Argentine market, although some are shipped to the Northern Hemisphere because of the six months' difference in season. The Tucumán oasis supplies the Argentine market with cane sugar.

Foreign Trade. The prosperity of Argentina and Uruguay is largely dependent on their ability to market a large volume of agricultural produce at a good price. Some of the complications involved can be illustrated by the following quotation.

> Favorable weather conditions throughout the planting and harvesting seasons of 1936-37 assured the bumper yields of wheat, linseed, and corn, which made the year 1937 outstanding. A strong European demand for wheat developed before the grain was harvested, and heavy shipments began to move out early in the year, so that exports from January to April 1937 were over 3,000,000 tons, or 77 per cent of the total for the entire year By June the exportable surplus had dwindled to about 750,000 tons, and on October 29 the Government prohibited the export of wheat and wheat flour This decree was rescinded on November 5 when it was reported that incoming supplies were adequate Prices for all agricultural products were higher than in 1936 and far above the levels of 1935, and the heavy shipments of wheat, linseed, and other crops brought excellent monetary returns during the first 4 months of the year. Agricultural conditions in the latter part of 1937 were less favorable than in the corresponding period of 1936 Serious droughts prevailed over wide areas, and in November and December a series of frosts caused much damage to the wheat crop and necessitated considerable replanting of corn. These conditions had little effect on business in 1937, but they were expected to have a vital influence on 1938. Final 1937 production figures in metric tons were as follows: Wheat, 6,782,000, linseed, 1,935,600, oats, 792,000; barley, 650,000; rye, 190,000; and birdseed, 29,800 The 1936-37 corn crop, amounting to 9,135,000 metric tons, was below the yields of 1934-35 and 1935-36, but the returns were favorable A strong foreign demand existed for corn and prices were good [1]

Since the exports of Argentina and Uruguay are mostly agricultural, they go largely to the industrial nations of Northwestern Europe. This fact is a great handicap to American manufacturers who wish to increase their Argentine sales. European goods are generally favored when equal in price and quality because Europe is Argentina's best customer.

QUESTIONS FOR DISCUSSION

1. How does the humid subtropical climate of Argentina differ from the same type of climate in the United States (compare Figs 76, 240, and 259)? Why? Does this have any effect on the agriculture of the Pampas?
2. What parts of the United States resemble each of the regions of Argentina? What American city roughly resembles Buenos Aires in its economic activities?
3. During what months are the common farm operations on a winter-wheat farm performed in Argentina?

[1] *Economic Review of Foreign Countries, 1937,* U S. Department of Commerce, Washington, 1938, pp. 157-58

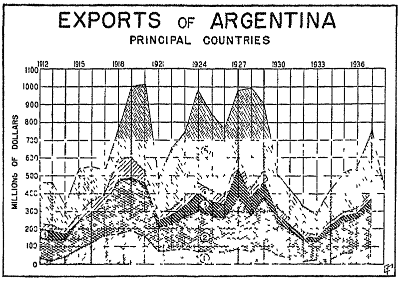


Figure 258 The numbers represent: (1) United States; (2) United Kingdom, (3) Germany; (4) France; (5) other countries.

Chile

The Valley of Central Chile. Central Chile, the most important part of the Chilean Republic, roughly resembles California in size, latitude, environment, and products. Chile is narrower than California, but like it contains a coastal range, a central valley, and a high mountain range on the east. The coastal range is semiarid and almost valueless, the Andes are steep and of value only for minerals, water power, and irrigation water. The real heart of Chile is the narrow irrigated Central Valley which averages twenty-five miles and often less in width. This central trough has been filled by silt and gravel from the mountains which have formed a layer of rich soil, in places more than three hundred feet deep. The perpetual snows of the Andes are the source of a usually adequate supply of muddy irrigation water which nourishes the soil and supplements the light Mediterranean winter rains.

The valley is divided into large estates, each with its system of irrigation canals, its church, school, and community of laborers. The crops are Mediterranean —wheat, barley, alfalfa, grapes, citrus fruits, olives, nuts, and figs—but irrigation permits the addition of humid temperate crops—corn, apples, peaches, and potatoes. Sheep and dairy and beef cattle are found on most of the estates. Except for wine and wheat, most of this agricultural produce is consumed at home, for distance from foreign markets has prevented any great development of the truck-gardening and canning industries.

As a topographic feature, this Central Valley continues on into southern Chile, but its climate becomes similar to that of western Oregon. Rain throughout the year has produced a heavy forest

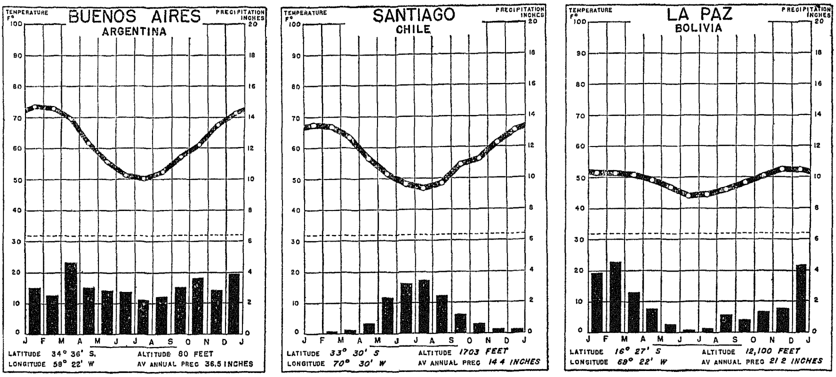


Figure 259.

growth, which pioneers are clearing with great difficulty. The cleared areas produce wheat, oats, potatoes, and other cool-temperate crops. The principal animals are beef and dairy cattle. South of 43° the valley ends and is replaced by a submerged, fiorded coast similar to that of southern Alaska. This part of southern Chile, in spite of its beauty, is economically almost valueless and is almost uninhabited except in the sheep-raising lands about the Strait of Magellan.

The Atacama Desert. The trade-wind desert of northern Chile is one of the most barren spots in the world. Scarcely any vegetation is found there. In a distance of nearly 500 miles only one stream reaches the sea. This aridity provided the conditions which permitted the accumulation of huge deposits of nitrates and other salts. Copper, silver, and iron deposits are also present. So valuable are these minerals that tremendous engineering feats have been undertaken to make it possible to exploit the minerals. Water is often piped over 100 miles (in the case of the port of Antofagasta, 230 miles) and foodstuffs are brought in from central Chile.

The Economy of Chile. From the point of view of site, central Chile has about as favorable an environment as can be found. Soft coal, lumber, water power, iron, and copper are available; the climate is pleasantly stimulating; and the intensive agriculture provides adequate and varied food for the inhabitants. Despite these resources, poor position has prevented any progress comparable to that in Northern Hemisphere areas with similar sites. Agriculture and simple manufacturing are carried on, largely for the Chilean market. The tremendous and easily exploited mineral wealth of central and northern Chile has caused Chilean businessmen to overlook many of the other possibilities of the Central Valley. In recent years about 40 per cent of the exports were nitrates and nitrate products (from northern Chile) and 35 per cent metals and metallic ores (mostly copper and iron ore). Since the opening of the Panama Canal, much of Chile's trade is with the United States, which is nearer than Europe and which has large investments in Chilean minerals.

Bolivia

Although a large part of Bolivia is in the Tropical Forest and Pasture regions, the economic heart of the country is on the Altiplano. More than 90 per cent of its exports consist of minerals from this region. Tin accounts for fully three-quarters of this mineral export, and silver, lead, and copper account for most of the balance. Mining, however, has little influence on the bulk of the population, except for the few who obtain work in the mines. Four-fifths of the people are Indians or half-breeds, and live much as their Indian ancestors have for many centuries. Primitive agriculture and the herding of llamas are their principal occupations. Even these activities are much restricted, for the cold of the plateau limits their crops to potatoes, wheat, barley, and a few vegetables. The bordering mountains shut out the rain-bearing winds, and irrigation is often a necessity. For like reasons, the pasturage is often scarce and sparse. On such

poor resources, only a low standard of living is possible. The railways, and the bulk of the imports, supply the mines and their foreign staffs rather than the Bolivian peon.

Isolation is the great handicap of Bolivia. It has no outlet to the sea except through the territories of its neighbors, and even these outlets are long, hard, and expensive. The railway from La Paz to the Chilean port of Arica crosses the Andes at an altitude of 13,986 feet The railway to the Peruvian port of Mollendo crosses at 14,688 feet above sea-level. The lowest pass (12,970 feet) is used by the La Paz-Antofagasta railway which is nearly three times as long as the La Paz-Arica line. Another railway connects La Paz with the port of Buenos Aires, 1637 miles away. Several river routes are used but the distance to the sea via either the Madeira-Amazon or the Paraguay-Paraná rivers is over 2000 miles.

Peru

Although the majority of the people live on the Andean highlands, the progressive portion of Peru is the coastal desert. Here are the principal cities (including the capital, Lima) and here originate most of the exports If copper from the Cerro de Pasco mines were excluded, more than nine-tenths of the exports would be from the coastal region. Beyond the Andes, Peru owns a large tropical forest area, but its connection with the outside world is poor and it has had little development

The Peruvian Coastal Desert. The Peruvian part of the Trade-wind Desert is almost as rainless as the Atacama Desert. Unlike the Chilean area, its most valuable products are the cotton and sugar of its small oases Its only important mineral resource is a small oil field in northwestern Peru. Aside from oil and the handling of Peruvian commerce at the ports, the life of the Peruvian Desert depends entirely on fifty-two short Andean streams, each of which has created a miniature Egypt.

The rich alluvial fans and waste-filled valleys of the usually plantless Peruvian Desert have long been intersected by a close network of irrigation canals. Storage dams are rare, however, and the water supply depends on spasmodic floods from the Andes. Fortunately, the lands are so near the equator that there is no great seasonal variation in temperature, and the agriculture is adjusted to the current water supply. Most of the land is owned by the large estates (*haciendas*) and is farmed by the peons who live in small adobe villages. The estates are usually efficiently managed, employ much modern machinery, and use crop rotations. Long-staple cotton, sugar, rice, tobacco, wheat, barley, alfalfa, beans, and fruit are the principal crops.

The Andean Highlands. This region in Peru consists of a great mass of mountains and intermontane plateaus cut by deep valleys. Although this highland was once the seat of the great Inca civilization, today, except near the mines, it is inhabited largely by Indians who practice a primitive type of agriculture. The crops raised vary with the altitude: corn, wheat, and fruits flourish on the lower slopes and in the deeper valleys; potatoes, barley, and quinoa (a small-grained cereal raised only in this region) predominate at the higher altitudes. Everywhere sheep, llamas, and alpacas provide additional food as well as the wool for clothing.

Mining conditions in the mountains are far from ideal, but the richness of the copper, silver, and vanadium ores has justified the high cost of mining and marketing The mines are located at such a high altitude that only Indians and half-breeds will do the physical work. A small colony of white managers and engineers is housed at each mine. The latter must be paid high salaries and given frequent vacations at low altitudes to enable them to keep in good health. Long railways have been built over some of the world's most rugged mountains to tap these mining regions; cable conveyors and llama pack trains are used to reach the more isolated mines. Fuel is generally lacking in the plateau so that the ores are usually concentrated rather than smelted Water power and imported fuel oil are used in the concentrating process—only the Cerro de Pasco mine in Peru has a near-by fuel supply of soft coal.

QUESTIONS FOR DISCUSSION

1. Why has the railroad from Buenos Aires to Valparaiso, Chile, not been generally profitable?
2. What is the approximate distance from Valparaiso to Liverpool and to New York via Panama? via the Strait of Magellan? What map projection would you use in measuring these distances? Could you calculate them only by having the latitude and longitude of the places traversed en route?
3. How does the environment account for the development of Inca civilization on the Andean highlands? Why are these highlands so backward today?

CHAPTER 45

SOUTH AMERICA (*Continued*)

THE COUNTRIES described in the preceding chapter are largely temperate or subtropical in environment. The remainder of South America, which includes more than half of its total area, is largely tropical. Its resources are often little known and little utilized. Regional boundaries on Fig. 257 are, in this part of the continent, necessarily tentative. For example, the Tropical Pastures region includes those tropical-savanna and tropical-steppe areas where the raising of cattle is, at present, the principal use of the land. Much of this land, however, is believed suitable for agriculture and may eventually, when transportation and other economic factors permit, be used for this purpose. Further exploration may extend the size of the pasture lands, because much of the area indicated as being "Tropical Forest" may be grassland or savannas. Early explorers followed the streams whose humid valleys often supported a dense forest which was not typical of the higher lands between the streams. Almost all maps of partially explored regions contain errors of this sort. Recently, survey by aerial photography has provided a good method by which such mistakes can be rectified in areas that cannot easily be surveyed on foot. But such surveys are expensive, and it will probably be several decades before the interior of South America is accurately charted.

Most of the environmental types found in tropical South America are found in Brazil. To avoid repetition, they will be described at length as they occur there and references to similar environments in other countries will be given in more summary form.

Brazil

Brazil is larger than the United States, but has only one-third as many people. Except for lack of coal and oil, it possesses the necessary physical resources for the development of a progressive industrial and agricultural state. Most of its people are, however, poorly prepared for such a complex economy and specialize in the production of a few products which they are accustomed to raise.

The retarded development of Brazil can be explained only by considering both its history and environment. Its lands have many potentialities, but during each period of Brazilian history only a few of these have been exploited. During the seventeenth century the Tropical Forest region along the South Atlantic coast was exploited for brazilwood and sugar. Slaves were brought from Africa for the plantations, and the interior was penetrated in an attempt to enslave the Indians. During the eighteenth century, gold and diamonds were discovered in the Brazilian highlands Their production, and the extensive grazing of cattle, then became the economic mainstays of Brazil. The nineteenth century brought a revival of agriculture with the export of sugar, tobacco, and cacao from the moist tropical lowlands, and the export of coffee and cotton from the highlands Wild rubber and Brazil nuts gathered from the Amazon Valley also played major parts in Brazilian trade.

The booms brought about by the rapid rise of sugar, minerals, rubber, and coffee in Brazilian trade attracted so much attention that, until recently, little attention has been given in Brazil to the encouragement of a well-rounded economy. The collapse of the rubber boom and the difficulties of the coffee plantations have, however, emphasized a need during recent decades for a diversification of products.

The Coffee Plateau. In tropical South America, the plateaus with their subtropical and temperate conditions are of outstanding importance. With the exception of the Guianas and Paraguay, which lack readily accessible plateaus, the largest cultural center of each country is on the plateau. These plateau areas have been called *Coffee Plateaus* because coffee is the typical cash crop. Many other crops, however, are raised for local markets.

The Brazilian Coffee Plateau is the central and highest part of the Brazilian highlands, an area of old crystalline rocks which rise abruptly, with an escarpment on the east, and slope gradually westward

toward the Amazon and Paraná valleys. Much of the upland had reached topographic maturity before the plateau was lifted to its present average height of 3000 feet. The surface is therefore gently rolling and rugged areas appear only near the edge of the eastern escarpment.

A complex geological history, involving many igneous intrusions, has produced a great variety of rock outcrops and a like variety of soils. The coffee districts toward the west utilize the rich volcanic *terra roxa* (red earth), those to the east are on heavy reddish clays derived from gneiss and granite. Other areas of little agricultural value have infertile soils developed from shales and sandstones.

The tropical savanna climate, modified by 1000 to 3000 feet of altitude, produces pleasant living conditions and is suitable for a great variety of industries. Although coffee [1] is still the predominant cash crop, other crops, including corn and cotton, occupy large parts of the arable land. Corn nearly equals coffee in acreage, and beans and rice are also important staple food crops. Cattle and swine are raised in large numbers, but the local market is so great that there is little surplus for export.

The mining areas still produce the gold and diamonds which led to the first exploitation of the region However, these industries are declining and the future of mining lies in the huge deposits of manganese ore and of hematite ore, which contains over 60 per cent iron. Although the iron reserves are probably the largest in the world, the production of iron ore is still small. Lack of coking coal and the limited market discourage local smelting and poor railway service to the ports (250-350 miles from the mines) discourages exportation.

The coffee industry has produced huge fortunes, and much of this capital has been invested in other industries on the plateau São Paulo is an important manufacturing center and supplies the Brazilian market with textiles, shoes, and many other easily manufactured articles Water power is used because of the lack of good coal in Brazil. Most of the manufacturing industries are successful only because of high tariff protection.

The Coffee Plateau is the commercial, industrial, and agricultural heart of the country. Coastwise steamers connect Santos, the port of São Paulo, and Rio de Janeiro with the plantation fringe along the coast of tropical Brazil and along the Amazon River.

[1] See pages 208-10 for a fuller discussion of the Brazilian coffee industry.

To the south is a hilly, temperate country which is connected with the coffee area by rail and steamer. To the west are the Tropical Pastures, connected with São Paulo by two railroads. These connections with the interior are insufficient to tap much of the resources of such a vast area but they are, nevertheless, in excess of the present traffic.

The Tropical Forest. The central part of the Amazon Valley and a coastal strip extending from Ecuador northward to Panama on the Pacific side and then around to Santos on the Atlantic side are covered by a dense tropical forest which is hard to penetrate. Its tall, closely set trees shut out most of the light as well as any refreshing breeze which might otherwise relieve the high temperatures. In the virgin forest there is little undergrowth, but lianas often climb from one trunk to another just underneath the overhead canopy of foliage. Along the streams the undergrowth is thicker and new varieties of trees appear which can survive the frequent floodings when the rivers overflow their banks. Swampy areas are often covered by an impenetrable mangrove swamp.

Most of the interior region has only a sparse population of Indians who are largely self-sufficient and hardly enter world trade. Occasionally they may bring some of the products of the forest to the river towns and trading posts, or these products may be obtained by white and half-breed traders who penetrate the jungle by canoe or motor launch. The products are many and interesting, but their total value is small. They include wild rubber, balata, chicle, Brazil nuts, ivory nuts, drugs, diamonds, gold, cabinet woods, and dyestuffs.

Plantations form a narrow strip of more intensive development along the coasts and on the banks of some of the major streams. The products vary, but cacao is most common. Bananas, sugar, rice, and coconuts are important plantation products along the northern coasts of South America. In eastern Brazil the plantation fringe is quite wide, and the products vary with the rainfall.

The Tropical Forests of Eastern Brazil. The southeast trade winds blow steadily against the South Atlantic coast of Brazil. The moisture precipitated as they rise over the highlands has created a narrow strip of tropical forest that extends from Santos almost to Cape São Roque. The region is never very wide—it extends inland only 100 miles at its widest part in the state of Bahía—but it contains the important Brazilian cities of Rio de Janeiro, Santos, São

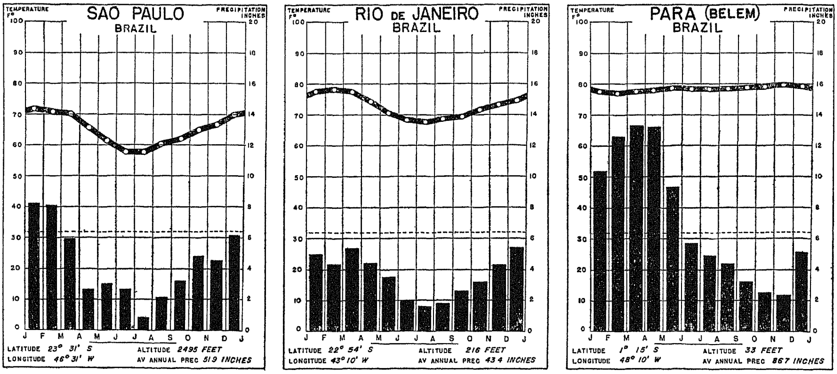


Figure 260. Although most of Brazil is tropical in climate, the temperatures on the Coffee Plateau are pleasant throughout the year

Salvador (Bahía), and Recife (Pernambuco)[1] During the first century of Brazilian colonization, parts of this region were the economic center of Brazil.

Cacao is the outstanding crop, especially in the rainy area in Bahía. This section was occupied by a dense tropical forest until about 1880 when the cacao industry was established. Here the physical conditions for cacao are close to the optimum and account largely for the rapid growth of the industry. Careless methods have prevented this region from being the leading cacao-producing area of the world.

In the cacao-producing area and more especially to the north of it, tobacco and sugar are major crops. These were the leading exports of Brazil before the rise of rubber and coffee. At present, most of these crops are used within Brazil.

The Amazon Valley. This part of Brazil is great in area but has only, at the most, 2,000,000 people. Its resources, especially for agriculture and lumbering, are known to be large, yet they have been developed slowly because of handicaps imposed by the tropical forest environment. The Amazon is one of the best and greatest of navigable inland waterways. Ocean vessels can ascend the river to beyond the Peruvian border, but the distances to be traversed are so great that few vessels take the trip. Here are great potentialities which can be developed when the world needs them; meanwhile the handicaps of the region have encouraged exploitation in similar but less difficult environments.

The Amazon Valley is a structural basin having roughly the shape of a Y with the base of that letter pointing toward the mouth of the river. Everywhere it is filled with unconsolidated alluvial sediments (Fig 256) which form a flat to gently rolling plain less than a hundred feet above the level of the Amazon. Wide strips of recent alluvium border the main streams within this plain Much of this flood plain is under water when the river is in flood Soils are often very fertile and are very productive where they are sufficiently elevated to afford adequate drainage.

After the collapse of the high rubber prices in 1912, the Amazon Valley continued to export rubber. The low price forced the people to gather other forest products which have not yet been produced on plantations. Brazil nuts were the major product. In recent years, balata, obtained from a tree closely related to the rubber tree, oil nuts, carnauba wax, dyewoods, and tanning extracts have been exported. The production of carnauba wax (used in candles, shoe polish, and varnishes) now exceeds in value that of wild rubber.

Soil surveys have indicated that there are large, unutilized areas of fertile soil in the Amazon. Why then are there so few plantations? The major difficulty arises from a scarcity of cheap, competent labor. Not only are laborers scarce but those that are available suffer from disease. After the land has been cleared,

[1] Many Brazilian cities are commonly referred to by two names (1) the name of the city itself, (2) the name of the Brazilian state of which the city is the capital. Thus Recife is the capital of the State of Pernambuco and is often referred to as Pernambuco.

a constant battle must be fought against weeds, insects, and plant diseases. Finally, the political situation is unstable, for Brazilian state and federal governments have often imposed burdensome export duties and other restrictions on the plantations. These handicaps are common in most tropical forest areas, but they are much harder to cope with in the Amazon Valley than in many European colonies where the governments are better able to combat the forces of nature.

QUESTIONS FOR DISCUSSION

1. Compare the Coffee Plateau of Brazil with the Piedmont of the American South.
2. Look up some information on the Ford rubber plantation in the Amazon. How successful is this project?
3. How far is it from São Paulo to Manaos? How difficult do you think it would be to make the journey? What would be the easiest way to go?

Tropical Pastures. A large part of the heart of tropical South America is tropical savanna and constitutes one of the world's greatest potential grazing reserves. The vegetation varies considerably within the area—often it is grass, sometimes open forest, and sometimes swamp, in a few cases, cacti, thornbushes, and other arid plants predominate. Everywhere, the alternating rainy and dry seasons are reflected in the seasonal rhythm of the vegetation.

Much of the savanna is unexplored by Europeans. On the more accessible edges, as in southern Brazil and Paraguay, half-breeds and Indians care for large herds of low-grade, half-wild cattle. Sometimes these herds are connected with scattered estates and estate villages near which some farming occurs during the rainy season. Isolated as they are from world markets, the only products of these herds that reach the outside are hides and beef extract. The dry season of these tropical savannas causes a serious water problem and restricts the herds and estates to areas near permanent streams.

In northeastern Brazil, the Tropical Pastures have developed agricultural islands. In moist years soil and weather are excellent for cotton and sugar cane. Severe droughts are, however, characteristic of the area. In dry years, the rainfall is insufficient even for cattle. A great drought in 1877-79 caused a large-scale emigration from northeastern Brazil into the Amazon Valley Later droughts have caused other large population movements to the moister mountain slopes or to other parts of Brazil.

Many attempts have been made to fight the recurring drought Over forty large reservoirs have been

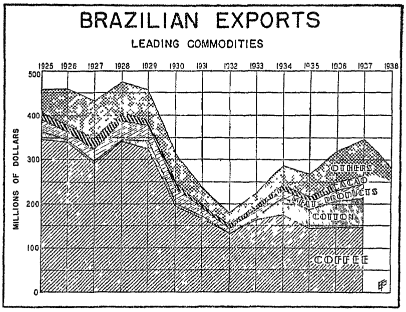


Figure 261. The rapid rise of cotton and "others" reflects the increasing diversification of Brazilian trade.

constructed for irrigation and domestic water supply. Wells have been dug wherever water could reasonably be expected Cattle are slaughtered at the beginning of the dry season to conserve the limited water and fodder. Nevertheless, the problem remains difficult in this land where the rainfall in three successive years was respectively 56, 24, and 8 inches.

Subtropical Brazil. This region, settled rather recently by German and Italian immigrants, has many of the characteristics of the neighboring regions. Its rolling uplands resemble the Coffee Plateau, but its climate is too cool for coffee. Its pastoral industries resemble those of the Tropical Pastures, although better position and a more advanced economy now permit the subtropical region to export chilled and frozen beef, instead of dried and jerked beef that is still shipped from the interior. The crops resemble those of the corn-growing part of the Pampas, but the land is more rugged, the farms smaller, and the farming more diversified. Another resource consists of large stands of Paraná pine, an important source of structural lumber for Brazil, Argentina, and Uruguay. Subtropical Brazil is rich in resources, but its products have not been so easily developable, nor are they so much in demand in European markets as those of the Pampas and the Coffee Plateau. As the Pampas becomes fully exploited, and as timber is cleared from the fertile lands of subtropical Brazil, this region will play an important part in adding to the exports of such products as are now shipped from Argentina and Uruguay.

The Foreign Trade of Brazil. A comparison of Brazilian and Argentinean foreign trade shows many of the characteristics of the two leading South Amer

ican countries. Although Brazil has four times as many people as Argentina, its foreign trade is only half as great. This reflects in part the greater self-sufficiency of Brazil, and in part the prevailing lower standards of living. Both Brazil and Argentina export agricultural produce; the difference in the items exported is a result of Brazil's more tropical position.

The principal customer of Brazil is the United States which buys over one-third of all the Brazilian exports. The United States and Germany are close rivals in Brazilian markets, for approximately one-quarter of Brazilian imports come from each.

Paraguay

Paraguay, one of the most backward countries of South America, is in that part of the Tropical Pastures known as the *Chaco* or *Gran Chaco*. The vegetation is a mixture of trees, bushes, grass, and swamp-grass. Except near the main streams, the land is used only for grazing.

The Paraguay and Paraná rivers have steamboat services which take Paraguayan products to the Argentine ports of Rosario and Buenos Aires. Cotton, quebracho extract, hides, preserved meats, yerba maté (Paraguay tea), and oranges are the chief exports.

QUESTIONS FOR DISCUSSION

1. Do you think the population of Brazil will ever exceed 100,000,000? Explain your answer fully in terms of geographic regions.
2. How would you account for the late settlement of subtropical Brazil?
3. Why is the United States more important in the foreign trade of Brazil than in the foreign trade of Argentina?

Colombia

Colombia borders on both the Pacific and the Caribbean, but most of its trade is handled through Caribbean ports. Its most progressive regions—the Coffee Plateau and the higher temperate plateaus about Medellín and Bogotá—are far from the sea. Its products reach the ports only after a long overland and river-steamer journey. The coffee area is much smaller than that of Brazil. Likewise, the individual estates are smaller. Usually they are at a higher altitude, and a higher grade of coffee is produced, partly due to more care in picking. Only such high-quality coffee could stand the high freight charges to the ports of Cartagena, Puerto Colombia, and Barranquilla.

Coffee and panama hats are the principal commercial products of the plateau; bananas and sugar are the important exports of the lowlands. Colombia is also important as a producer of gold and platinum in the Atrato River district near the Pacific Coast. Petroleum has been discovered in the Magdalena Valley, and is now second only to coffee in Colombian export trade. Over half of Colombia's foreign trade is with the United States.

Ecuador

As its name suggests, this backward country is located astride the equator. However, three-quarters of the people of Ecuador live in the cool climate of the Andean highlands These mountain dwellers are very similar in type and occupations to the Indians and half-breeds of the highlands in Bolivia and Peru. Unlike these countries, however, the plateaus and mountains of Ecuador contain few minerals and therefore contribute almost nothing to the foreign trade.

The Tropical Forests of Ecuador are found both east and west of the central highlands. The eastern forest is little known and is inhabited mainly by primitive tribes of Indians. The forests near the Pacific contribute cacao, bananas, and vegetable ivory to world trade, while coffee and panama hats are produced on the adjacent lower slopes of the Andes. Small amounts of petroleum are produced in southwestern Ecuador.

Venezuela

After a century of wars, revolutions, and economic stagnation, Venezuela has within the last quarter century made steady progress. The prosperity caused by the exploitation of the Maracaibo oilfields, together with the dictatorial rule of Juan Vicente Gomez, have enabled the country to pay off its national debt, build roads and railroads, and expand its trade.

Venezuela is more fortunate in its environment than its neighbor, Colombia. The regions found in each country are similar but each region is more easily exploited in Venezuela than in Colombia. Venezuela's oilfields are nearer the sea than those of Colombia; her Coffee Plateau is less rugged, better served by railroads, and nearer the principal ports; the Venezuelan tropical pastures (*llanos*) and the interior Tropical Forests areas are easily reached by the Orinoco River and its tributaries.

Petroleum products account for four-fifths of the

value of the exports. Coffee from the plateau is a poor second. Cacao from the coastal lowlands, gold from eastern Venezuela, and hides and cattle from the Llanos are the only other important exports.

The limited number of commodities exported from Latin American countries often give an inaccurate impression of the national economies. Within most of the countries there exist many diverse industries which supply local needs. Thus, the Coffee Plateau of Venezuela, on which live the majority of the Venezuelan people, produces corn, wheat, tobacco, rice, sugar, cotton, fruits and vegetables, in addition to coffee. Cattle and goats are raised locally, while other cattle are brought in from the Llanos for fattening. The modern cities of Caracas and Valencia manufacture such goods for home consumption as textiles, hats, shoes, nails, beverages, lumber products, and glass.

The Guianas

The most successfully utilized part of the Tropical Forests is in British and Dutch Guiana, but even here the strip of plantations extends only ten or twenty miles inland, and the partially exploited area rarely more than fifty miles. To accomplish this limited exploitation it was first necessary to import large numbers of Negro slaves and later many Asiatic coolies. The population today includes scattered tribes of Indians, several hundred thousand Asiatics, about the same number of Negroes, and a small sprinkling of white managers and officials. Sugar, molasses, rum, rice, cassava, and cacao are the principal exports from the plantations. Hardwoods—especially mora, rosewood, and greenheart—bauxite, gold, and diamonds are the leading exports from the interior.

French Guiana is noted mainly for its prison camps. There is a small acreage devoted to crops for home consumption. The forest, however, provides the only exports: gold, balata, and rosewood.

The Expansion of Latin American Trade

So much has been said about the expansion of American trade southward that it seems appropriate here to reconsider the bases of the trade of the United States with Latin America. Considerable expansion of this trade has often been predicted but not yet realized. At present, Latin America supplies only one-fifth of American foreign trade and well over half of that trade has been with Mexico and the countries around the Caribbean.

Difference in Products. The most progressive parts of Latin America produce articles which duplicate staple American products. The Pampas duplicate the agricultural products of the Heart of North America; Patagonia and Chile duplicate the products of the West; eastern Brazil produces many of the products of the South. Only where there is a difference in quality and price (for example, the corned beef of Argentina, Uruguay and southern Brazil) or a shortage in the American market (the wool and flint corn of Argentina) is there much chance of developing a market for Latin American temperate-zone products in the United States.

On the other hand, tropical Latin America produces many articles which are rarely duplicated in the United States. As these products become known, American demands arise for them. Likewise, tropical peoples often desire those American products which cannot easily be produced in the tropics. Here then is a firm basis for more trade but that trade must be initiated by the United States because the tropical consumers have no purchasing power for new goods unless new markets for their goods are first provided. The development of the banana trade by the United Fruit Company has shown what can be done in opening up tropical areas to American business.

The Standard of Living. Few Latin Americans can afford most of those products which the average American considers a necessity. Brazil may be taken as an example.

> The standard of living of the greater part of Brazil's population is low, probably not more than 15 per cent being able to purchase anything beyond meager living necessities This 15 per cent represents the extent of the market for luxury and semiluxury articles, and probably not more than a third of this number (2,500,000) could be regarded as potential purchasers of such products as automobiles, electric refrigerators, radios, washing machines, and other similar goods in common use by the middle classes in the United States.
>
> Considering Brazil as a whole, only 1 in every 12 families lives in a wired home, 1 in 22 families owns a radio set, 1 in 433 families owns an electric refrigerator, 1 in every 50 families has a telephone, and 1 in every 102 families owns an automobile.[1]

Latin American incomes are especially low within the tropics. There the average family lives in a one- or two-room hut, crudely built of mud, stone, or pine boards. The furnishings are plain and usually homemade. Modern sanitary arrangements are usually absent. The daily wage, when work is obtainable, ranges

[1] Quoted from p. 51, *Commercial Travelers' Guide to Latin America, Part II, East Coast of South America,* U. S Dept. of Commerce, Washington, 1938.

from twenty cents to a dollar a day. If the family lives away from the crowded urban districts. a small garden probably supplements this income.

Purchases are necessarily limited to food, cheap cotton clothing, tobacco, liquor, and a few trinkets. The poorer classes often seem satisfied with this low standard and are rarely willing to work harder to increase it. This attitude is not surprising since heat, malnutrition, and chronic disease are not likely to foster ambition. The impulse for progress must at first be supplied by the government, the aristocracy, and the foreign businessman.

Common Culture. Despite a century of political separation, Latin America has maintained many of its commercial and cultural relations with Spain and Portugal. Most Latin Americans find that common manners and tastes make it easier to do business with the Latin nations of Europe, Spain, Portugal, France, and Italy, than with the Anglo-Saxons of temperate North America. This consciousness of common culture is often clearly reflected in the trade statistics, especially those of Latin American imports.

Stability of Government. Most of the independent governments of Latin America leave much to be desired from the point of view of the foreign trader and investor. Revolution, legal discrimination, exorbitant taxation, and inadequate policing have at times been common in most Latin American countries. Foreign property rights are relatively secure in most of these countries largely because of the influence of the United States. The Monroe Doctrine has forced the United States to protect property rights of all foreigners to prevent intervention by European powers.

Accessibility. The populous and progressive parts of Latin America are with a few exceptions either on the seacoast, along navigable streams, or on one of the relatively few railroad lines. Recent developments have consisted mostly of an expansion and intensification of production in these areas. The development of the resources of the undeveloped interior of South America must await better transportation and the solution of disease and other problems of tropical exploitation.

The Outlook. The preceding analysis shows that the expansion of American trade in Latin America will not be easy. Most Latin American countries will tend to favor European countries rather than the United States because those countries are better customers, produce cheaper goods, and are more similar to Latin America in culture.

QUESTIONS FOR DISCUSSION

1. Examine a physical map and criticize this statement. "Except in size, Brazil, Colombia, and Venezuela resemble one another."
2. Why are there so few transcontinental railroads in South America as compared with North America? Why has air transport become very important in South America?
3. Bolivia has been engaged in serious boundary disputes with Chile, Peru, Paraguay, and Brazil What geographic factors may have contributed to these disputes?

ANALYSIS OF PLATE XVIII: LATIN AMERICA

XVIII A. This picture shows but a small part of a huge coffee *fazenda*. There is little in the picture to suggest that this is in the tropics. The weather is rarely too hot or too cool for comfort on the Coffee Plateau of Brazil.

XVIII B. Rio de Janeiro is considered one of the world's most beautiful cities. It has also one of the world's finest harbors (Fig. 197). Nearness to water and exposure to the southeast trades moderate its tropical climate.

XVIII C. The Pampas are extremely flat and have very poor natural drainage Streams are rare and the water collects in pools or soaks into the ground The domestic water supply is pumped from the water table by windmills. The soil consists of silt- or clay-loams and at the surface is either loess or fine volcanic ash The natural vegetation is grassland, although the rainfall is sufficient to support a forest This fact has led some geographers to suppose that the vegetation was altered by fires set by the Indians

XVIII D. A map of this plantation appears on p 368 Sugar cane has just been harvested in the foreground. The scattered trees in the background are characteristic of tropical-savanna areas

XVIII E. The Peruvian city of Arequipa (population about 55,000) is situated at the foot of the snow-covered volcano, El Misti The city, located in an oasis, is an important agricultural center and wool market. The Andes are in a seismic belt and earthquakes are common near them Arequipa has been rebuilt several times after severe earthquakes.

CHAPTER 46

EURASIA

EURASIA might well be called the two-faced continent. Its western margins face the Atlantic and Mediterranean and have developed a type of culture known as "European"; its southeastern margins face the Pacific and Indian oceans and have developed the Oriental cultures. Between these two major culture areas, and spreading to the northward, is a relatively poor and undeveloped area consisting of grasslands, deserts, oases, cold forests, high plateaus, and tundra. This area, so backward today, was, in its southern half, once the site of the world's leading civilizations, and from these centers fertile ideas spread eastward and westward to aid the development of the civilizations of Europe, Egypt, India, China, and Japan.

The boundary between Europe and Asia is hard to draw, for, physically and historically, the two areas are closely connected. Hence, an increasing number of writers are using the term *Eurasia* for the entire land mass. Since Africa north of the Sahara is closely tied up with Eurasia in its political and economic development, it will, for convenience, be included in this discussion.

Culture in Europe and Asia

Eurasia is a continuous, physical whole, but its two major subdivisions are so different that it has long been customary to separate them. The two names for these subdivisions are thought to have originated in the neighborhood of the Aegean Sea. To the sailor on this sea, Asia appeared toward the sunrise and the term "Asu"—meaning sunrise—was applied to it. Greece was toward the sunset and was called "Ereb" (Europe), which meant sunset. In antiquity, as today, the names stood for a type of culture as well as the land itself. When European culture is referred to, it suggests such cultural aspects as democratic institutions, science, hygiene, rationalistic philosophy, and industrialism; Asiatic (or Oriental) culture implies mysticism, asceticism, despotic institutions, handicraft industries, low standards of living, and conservatism. The contents of the two cultures have altered from time to time because of invention and cultural diffusion, but each culture has retained many distinctive characteristics.

The Importance of Europe. Peruvian potatoes, Brazilian cassava, and American Indian corn are common crops in the appropriate environments in the Old World; while Abyssinian coffee, Hindu sugar cane, Asiatic sheep, goats, horses, and cattle are equally common in the New World. Many other commodities have spread to opposite sides of the globe. But this diffusion of products has generally been accomplished by Europeans, not by the people first utilizing the product The people of Europe (especially western Europe) have made it their business to explore the world; to select what they thought good, and to spread these commodities, ideas, and customs throughout the world.

The purpose of this world-wide exploration, which began intensively about 1450, has not generally been scientific. The desire for gold, spices, and trade has been the dominant incentive. Missionary enterprise

ANALYSIS OF PLATE XIX: NORTHWESTERN AND EASTERN EUROPE

XIX A. Note the careful cultivation of the rolling lands, the forests are restricted to the hills.

XIX B. Level land, large fields, cereal cultivation, and windmills are characteristic from Belgium to the Urals.

XIX C. The farm has been cut out of the forest, and the farmhouse may have been built from local wood. The podzolic soils are poor and pasture rather than crops predominates Many of the crops are for local consumption: rye, potatoes, and root crops, while butter, flax, and sugar-beets are produced for the market.

XIX D This Irish farm also exports butter, but otherwise it contrasts with the Latvian farm: land entirely cleared, house built of local limestone; rich limestone soils; income from dairying and pig-raising.

XIX E. Machinery has, within the present century, become an integral part of eastern European agriculture.

XIX F. The importance of transportation in the operation of a modern iron and steel industry is shown strikingly. Here canal, railroad, road, and overhead tramway are used in the handling of the bulky materials.

has also been important in exploration, and has often, consciously or unconsciously, aided the purposes of the trader and the imperialist. While in pursuit of trade, Europeans have found it convenient to make political conquests and to establish permanent colonies. So extensive has this conquest been that today Japan is the only important country that is entirely independent of some measure of control either by Europeans or by the descendants of European colonists.

Europe's importance, not only in political influence but also in productivity, is altogether out of proportion to her size. Her peoples make up only one-fourth of the earth's population and occupy only one-fifteenth of the earth's land area, but they produce, in Europe, more than one-half of the world's commodities and, through ownership and management, have a controlling influence on much of the commercial production in non-European lands. European agriculture accounts for more than four-fifths of the world's rye, potatoes, sugar beets, and flax fiber, and for more than half of the world's oats, barley, grapes, apples, and dairy products. European mines produce about one-half of the world's iron ore, coal, and potash, and important quantities of many other minerals. Likewise, in manufacturing, commerce, science, and art, Europe leads the world, although her dominance in these fields has lessened during the twentieth century. If the output of countries such as the United States, Canada, Australia, and Argentina (essentially outgrowths of European civilization) are included, Europeans produce the bulk of almost all major commodities except silk and certain raw materials, such as rubber and cacao, which are suited only to environments that are scarce or lacking in Europe.

Asia. The Asiatic part of Eurasia is a land of extremes. Its wide plains contrast with its high plateaus and even higher mountains. It includes some of the driest places in the world as well as the rainiest; the coldest as well as the hottest. Long famed for its gold and precious stones, its fabulously wealthy rajahs and its mandarins, Asia also contains the greatest mass of poverty-stricken humanity to be found anywhere in the world.

To many businessmen Asia seems far less important than Europe, not only because it is less productive than Europe, but because each inhabitant represents so little in purchasing power. This seeming unimportance is to a large extent due to retarded development. The next century may see the tremendous human and physical resources of Asia developed as rapidly as were those of North America during the nineteenth century. Meanwhile, it should not be forgotten that a small increase in the productive and consumptive power of each of the 1,000,000,000 Asiatics would result in a tremendous increase in total Asiatic trade.

A glance at Asia's past quickly demonstrates her immense contribution to civilization. It seems probable that man evolved there, and it is certain that many of our common domesticated animals—cattle, horse, goat, sheep, fowl—and cultivated plants—wheat, rice, barley, sugar cane, peaches, apples, and others—were first utilized on that continent. Countless hordes of people have invaded Europe from Asia and have contributed racial and cultural elements to modern Europe. The Hungarians, Finns, Turks, Arabs, and Jews are some of the peoples who have entered Europe from Asia within historic times The cultural contributions of the Asiatics include such important devices as the alphabet, Arabic numerals, gunpowder, porcelain, and the compass Asiatic thinkers have also contributed an important part of the world's stock of philosophical and religious ideas

Asia is a continent of extremes in cultural development. Unlike Europe, its civilization has not developed as a unit, but in a number of geographic pockets. These pockets have given each area much more cultural individuality than has been developed by any one country or section of Europe. Hindu, Japanese, Persian, and Chinese cultures have much less in common than the cultures of England, Germany, Italy, and France.

Northern Africa and the Unity of the Mediterranean. Northern Africa is but a continuation of the lands of winter rainfall which inclose the Mediterranean Sea. In culture it has always been closely allied with the civilizations of the Near East. Since the beginning of history, caravans have brought goods and ideas from adjacent Asia over the Isthmus of Suez to Egypt. Somewhat later, boats carried goods and ideas across the Mediterranean to southern Europe and, under Alexander the Great and later under the Roman Empire, European merchants, armies, and ideas conquered northern Africa. In the Dark Ages, under the stimulus of new-born Islam, African culture advanced into Sicily and Spain until, culturally, Africa began at the Pyrenees. Within the last century Spain, France, Italy, and England have brought northern Africa under their control and the process of Europeanization has begun. Thus Africa, Asia, and Europe around the Mediterranean are not

permanent and separate cultural entities, for the cultural boundaries are uncertain and shift continuously. Water bodies have often been spoken of as natural boundaries, but a study of history shows that since the development of ships, water unites more often than it separates.

Environment and the Diverse Development of Europe and Asia

The problem of the interrelation of geography and history is nowhere more interesting or more complex than in Eurasia. It is intended in the following paragraphs to indicate some of the more obvious and more important of these relationships. The following discussion will be more convincing if the reader will check for himself the points mentioned on appropriate maps.

Position. Europe is centrally located among the five other continents. Its populous section is nearer to Africa, North America, and South America than the populous part of Asia. Europe faces the Atlantic, which is relatively narrow compared with the Pacific and Indian oceans, which Asia faces. Furthermore, the Atlantic slopes of the Americas are much larger in area and more productive than the Pacific slopes. European civilization was able to colonize the vast fertile areas of the Americas, while Asiatic civilizations were only able to colonize the East Indies.

Shape. Europe has been described as a peninsula of peninsulas. No considerable part of Europe is far from water bodies. This fact not only aids accessibility, but moderates temperatures and increases rainfall. Sheltered inland seas also provide for easy coastwise commerce.

Asia, on the other hand, contains few seas or gulfs which penetrate the interior. Much of the highly developed area is on the coastal plains of the mainland and adjacent archipelagoes, and in the valleys of a few large, navigable rivers—such as the Tigris, Indus, Ganges, Mekong, Si Kiang, and Yangtze Kiang. Large areas in Asia are more than one thousand miles from the sea and lack any connection with it by navigable waterways.

Relief. Eurasia has three conspicuous features of relief. To the north is the great, almost unbroken plain which extends from northwestern France to northeastern Siberia. To the south of this plain is a mountain core, whose backbone includes a series of young mountains (the Pyrenees, Alps, Caucasus, and Himalayas) which are often bordered by lower and older highlands—such as the Jura Mountains which trend almost parallel to the Swiss Alps. South of the mountain core is a section of mountain and highland spurs which separate numerous small plains and fertile river valleys. Among these latter are the valleys of the Tiber, Po, Euphrates, and the great valleys of Monsoon Asia, all of which have been important centers of civilization.

The amount of relief is great in both southern Europe and southern and central Asia, but in Europe the high ranges are narrow and cut through by low passes and river gaps. Among the important river-valley routes through the mountains of Europe are the Morava-Vardar gateway in Yugoslavia, the gateways cut by the Elbe and Oder rivers through the mountains of northern Bohemia, the Rhone-Saône-Rhine gateway through the mountains of eastern France and southwestern Germany, and many others. In contrast, most Asiatic mountains are decided barriers with high passes. For this reason, overland travel between China and India has been confined to small loads and highly valuable goods. Asiatic mountains tend not only to retard commerce, but to prevent it.

Climate. Most of Europe has a temperate oceanic climate with no great extremes between summer and winter. Most of Asia on the other hand has a continental climate with extreme seasonal changes. Asia probably suffers more from droughts, floods, duststorms, hot spells, and cold spells than any other continent, while Europe is remarkably free from such natural disturbances. Almost all of Europe is in the stimulating middle latitudes, while the fertile part of Asia is largely in the tropics. Much of Asia which is in the middle latitudes either suffers from high elevation (which gives it an almost arctic climate), or else is too arid for intensive development.

Soils. The soils of Asia, in general, probably surpass those of Europe. Much of western Europe's soil is sandy and requires a high degree of fertilization. The soils of eastern Europe (including the black soils of Russia) are much richer, but are often poorly utilized. Mediterranean soils are generally good, but suffer from long use.

The fertile black-soil belt of Russia continues into Siberia and provides a rich area for future development. The soils of the densely populated sections of Asia are largely rich, water-deposited silts. In China, Japan, Indo-China, and Java, the fertility of these soils has been maintained and increased by as thorough care as is found anywhere. For more than four thousand years the Chinese have farmed their fields,

but soil exhaustion is rare. In India the soils are poorly cared for as a rule. There are, however, many fertile soils in India, such as the alluvial soils of the Ganges Valley and the volcanic soils on the Deccan Plateau.

Vegetation. Except in northern Eurasia and some of the forests of Indo-China and the East Indies, the natural vegetation has been largely altered by man. From this vegetation man selected most of the plants which are today the basis of agriculture throughout the world. So far as can be determined, most of these came from Asia, especially from the oases and semiarid regions

Animal Life. Like the plants, much of the wild animal life has been destroyed except in the forest areas, semiarid plateaus, and Arctic Eurasia. Here, hunting and trapping for furs and food remain important Most of the world's domestic animals also came from Asia. The present Eurasian distribution of these is very uneven. Northwestern Europe has large herds of dairy cattle, while in Mediterranean Europe sheep and goats are predominant. India also has large dairy herds. China and Japan, on the other hand, have relatively few large domestic animals, for there is little room for them.

Minerals. Eurasia is highly mineralized. Almost no part of the continent lacks some important mineral resource, and iron and coal, the basic minerals for industrial development, are widely distributed. Of these resources, only those of Mediterranean and northwestern Europe and Japan have been thoroughly exploited.

QUESTIONS FOR DISCUSSION

1. How does Europe's position, shape, and relief compare with that of each of the other continents?
2. Do the major geographic regions of Eurasia shown in Fig. 262 coincide with the climatic regions, as shown in Fig. 72? Do relief features determine the regional boundaries in many cases?
3. Why has the Baltic Sea been less important than the Mediterranean in European history?

Major Geographic Regions of Eurasia

Eurasia may be conveniently divided into eight major regions (Fig. 262), each of which has certain distinguishing characteristics These characteristics, however, are not uniformly present within each area and are given here only as broad and useful generalizations. Furthermore, the boundaries of these regions are only approximate and represent in most cases the centers of transition zones rather than lines of sudden change.

The Mediterranean Lands. European civilization first developed in Mediterranean Europe, probably because of the easy trans-Mediterranean contacts with the ancient civilizations of Egypt, Mesopotamia, and Phoenicia. The region is characterized by its mild climate, with adequate winter rains but almost rainless summers. Minerals in large quantities are lacking and therefore the region is not so suitable for a great industrial civilization as Northwestern Europe. The shift of the world's trade from the Mediterranean routes to the Atlantic routes is another reason for decline of the Mediterranean Lands.

The exports of the Mediterranean Lands are largely foodstuffs, raw materials, and simple manufactured articles; the imports are complex manufactured goods, lumber, fuel, industrial raw materials, and fish. Overcrowding and political disturbances have caused a large emigration which is an important item in trade, for large numbers of the emigrants have sent money back to their homelands.

The Nomad Lands and Their Oases. This region of grassland mixed with desert contains two radically different cultures. the nomadic culture on the semiarid lands and the oasis culture, which has developed wherever a stream or spring provides water. The nomads have performed much more important functions than merely herding tremendous numbers of sheep, horses, and cattle. The cargoes of goods which they have carried across the desert wastes brought Chinese and Hindu products to Europe when the country of manufacture was veiled in mystery. When pasture has been scarce, or when the wealth of the oases aroused their greed, nomad armies of swift-moving cavalry have conquered the oases and overflowed into the agricultural lands of China, India, Egypt, Mesopotamia, and Europe. At least half the history of Asia revolves around the struggle between the nomads and the sedentary population. Often the nomads won, settled down to enjoy their loot, and frequently took over the wealth and culture of the city dwellers until, in turn, they were conquered by the next nomad horde.

The Nomad Lands are, at present, of little importance to the world economy. Their people need buy little, since the milk, hides, meat, and wool of the herds are complementary to the agricultural products of the oases. The region, except for the few large oases, exports little—some wool, rugs, a few animals, and dried fruits (dates, etc.) make up the bulk of the outgoing trade, which is handled mostly by caravans. A few manufactured articles are imported in exchange. The caravans are dwindling in number and impor-

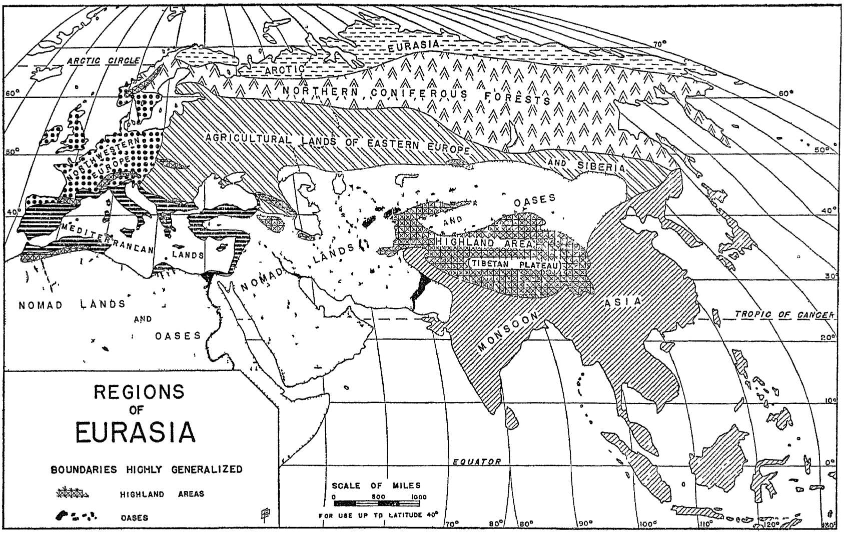


Figure 262 (Drawn on part of Goode's Homolosine projection, copyright by the University of Chicago Press)

tance, for the trade between Monsoon Asia and Europe is now carried by the "camels of the sea" (an Arab idiom) instead of the "ships of the desert."

Monsoon Asia. This extensive region is characterized by seasonal changes in wind direction which result in great seasonal changes in rainfall and temperature. The rainy season comes in each place when the winds are blowing from the sea over the lands; the dry season comes when the wind blows from the land over the ocean. In most of Monsoon Asia the rainy season occurs in the summer when the wind blows from the south or southwest. In parts of the East Indies, Indo-China, and Ceylon the rain also falls in winter, for the north winds strike these areas after crossing the sea.

Most of Monsoon Asia is agricultural and is, therefore, almost wholly dependent on the monsoon rains. Rice is the most characteristic crop except along the northern margins where wheat and barley predominate. Except in India, animals are relatively scarce. Low standards of living, very intensive farming, and a very dense population on the plains areas are the outstanding human characteristics of the region as a whole.

Until recently Monsoon Asia consisted largely of local communities leading an almost self-sufficient life. During the last century an increasing proportion of the land has entered into production for world markets rather than for local consumption. Along with the plantations, manufacturing cities have grown up as at Bombay, Calcutta, Hong Kong, Shanghai, Tientsin, and numerous Japanese cities.

The Agricultural Lands of Eastern Europe and Siberia. This region is the land of the Slav. It is relatively undeveloped and, compared with most of Europe, has backward agriculture, poor transportation, low standards of living, and little manufacturing. All of these characteristics are accentuated toward the east. The region includes belts that, as regards climate and soils, are similar to the Corn Belt of the United States (Hungary, Rumania, and southern Russia) and the wheat belts of the United States and Canada (south central Russia and most of the agricultural lands in Siberia).

The periods of control by the Turk (in the Balkans and Hungary) and the Mongols (in Russia until 1480) have added to the backwardness and natural isolation of eastern Europe. Languages and alphabets quite dif-

ferent from those of western Europe have further discouraged cultural and commercial intercourse. Even today, as the result of these barriers, Slavic Europe tends to have a decided Oriental tinge.

Adjacent Siberia is still largely in the pioneering stage. Unlike the United States, it still contains large areas of good, unused land. Consequently, there is no problem, as in the western United States, of developing new techniques of production. The main problem is transportation, and the present products are all such as can stand considerable shipment: furs, wild honey, wool, hides, skins, and butter. Grain and lumber, also important products, are shipped only from sections near the Trans-Siberian Railway.

Bowman says of the problem of Siberian development in his authoritative book on pioneering:

> Distance is so great a handicap to production in Siberia that railway outlets, west and east, will not serve to lighten the burden of transport costs. A self-contained economy is required, and the time for it is long overdue Freight rates to distant markets are too high. A commercial liaison of unlike regions is one way out. Subsidized transport is another so far as the need for outer markets continues in a balanced development of Siberian life. Until these measures are put into effect Siberia can be only an outlying colony of European Russia The outlets are now choked to the world-encircling and life-giving sea.[1]

The Northern Coniferous Forest. This region closely resembles the corresponding section of Canada. It contains the same kinds of trees, the same animals, and is inhabited by people whose manner of life resembles that of the Canadian Indians. Trapping and fishing are the main activities except along the southern and western margins where lumbering and farming are carried on by Russian settlers. Like the agricultural lands of Siberia described above, isolation is an outstanding problem.

Arctic Eurasia. This area of tundra and very sparse coniferous forest resembles the land of the Eskimo in North America. Its inhabitants are mostly Lapps, Samoyeds, and other Mongoloid peoples, who get a poor living by reindeer herding, hunting, and fishing. In northern Sweden the presence of high-grade iron ore has caused a local area to be more intensively developed. In Siberia the rivers and the adjacent Arctic Ocean are frozen over most of the year so that the tundra is difficult of access. Furthermore, the land is often low, swampy, and apparently lacking in mineral resources. Its present and probable future commercial importance is almost nil.

[1] Isaiah Bowman, *The Pioneer Fringe*, p. 256. Special Publication No. 13, American Geographical Society, New York, 1931.

Highland Areas. The highland areas have helped to differentiate the characteristics of the various parts of Eurasia and by varying the products have created a basis for trade. At the same time, the highlands are also a trade barrier. The local economy of the highland areas is generally pastoral with some supplemental income from small handicraft industries. Where the mountain areas are near centers of population, the tourist trade may become a major source of revenue. When the mountain area contains passes or can be tunneled through, the transportation of goods may add to the revenue if highly developed areas are on each side of the highlands.

The Alps are a good example of a developed highland area. The Tibetan Plateau and the Himalayas represent the opposite extreme. The Himalayas, the highest mountains in the world, have many peaks more than 25,000 feet high and passes more than 14,000 feet. North of this range is the Tibetan Plateau which is from 10,000 to 14,000 feet above sea level. It is one of the most inaccessible places in the world. Mountain ranges and deep canyon-like valleys make travel difficult and impossible during the gales and snows of winter. The mountain barriers on all sides shut out the rain-bearing winds so that aridity adds to the disadvantages of this cold, rugged land. A few nomads live in the better valleys, but otherwise it is unoccupied. Caravans rarely cross it, and its main function has been to retard the spread of culture between India, Indo-China, China, Turkistan, and Mongolia.

Northwestern Europe. This region is characterized by a stimulating climate which is relatively cool in summer and mild in winter. Rainfall is adequate for all crops that can stand the cool temperatures, and drought is rare. Agriculture is intensive and is primarily devoted to supplying local urban markets. Manufacturing and commerce are the basic industries in the area, and agricultural and extractive industries are subordinate to industrial needs. All of this region imports raw materials, to supplement the coal and iron available in much of the area, and exports manufactured goods. Important as these activities are, they have less influence on world affairs than the political and economic leadership of Northwestern Europe which, until recently, had remained almost unchallenged for three centuries. Because of this leadership, it is appropriate that this region be discussed fully before the other Eurasian regions are described in detail.

QUESTIONS FOR DISCUSSION

1. What prevents Monsoon Asia from obtaining more of its food from the agricultural lands of Siberia?
2. Are there any other Asiatic railway routes which might be constructed which would equal the Turk-Sib route in potentialities? Where? Would these railways be profitable during the first decade of operation?
3. To what extent do the geographic regions of Eurasia have environmental counterparts in North America?

Northwestern Europe

Economic History. Only since the Middle Ages has Northwestern Europe been the leading world center. Until that time the center of civilization was around or to the south and east of the Mediterranean Sea, and Northwestern Europe was peripheral rather than central in position. So long as civilization was agricultural rather than industrial, the sunny lands of southern Europe were preferred over the cool, mineral-rich lands to the northwest. While navigation was limited to the coasts, the inland sea routes of the Mediterranean were superior to the more extensive open sea routes which centered on the North Sea lands.

The soldiers and, later, the missionaries of Rome carried Mediterranean civilization into Northwestern Europe, where it was gradually absorbed by vigorous Teutonic and Celtic peoples. These peoples had lived a seminomadic life devoted primarily to hunting, herding, primitive agriculture, and raiding, but, largely under the influence of the new culture, they gradually settled down to a sedentary life. The Romanization of these peoples was far from complete when incursions of nomads destroyed the Pax Romana and left a legacy of almost continuous petty wars, which forced most of the people to live in or near fortified towns.

After 1000 A.D. the intellectual and commercial life of Europe, which had stagnated during the Dark Ages, slowly reawakened. This renaissance started in the Mediterranean Lands, but several influences helped to shift the center of progress to the northwest. The expansion of Mohammedanism along the southern Mediterranean and into Spain and southeastern Europe destroyed considerable Mediterranean and Oriental trade. Southern Europe was now on a battle front rather than in the center of the civilized world, and its division into a large number of petty states ill fitted this vanguard position. At the same time Northwestern Europe was progressing. The Hanseatic League (founded about 1150 A.D.) increased the safety and quantity of trade around the North and Baltic seas. Kingdoms slowly united the myriads of feudal states into nations. Workmen ceased to be mere imitators of Rome and developed advanced skills of their own, which finally led to the Machine Age.

The discovery of the Cape of Good Hope route to the Orient destroyed the monopoly which Mediterranean ports had had on Oriental trade; and the development of American colonies completed the shift of the world's commercial center to the North Sea and Atlantic lands. This new trade brought increased prosperity to Northwestern Europe and, indirectly, made possible many educational and scientific advances. Industrialization, with its emphasis on science, coal, iron, and foreign trade, finally brought into full play the numerous advantages of site and position which are characteristic of Northwestern Europe.

The development of transoceanic navigation put to use the numerous routes which lead conveniently to the North Sea, the commercial center of gravity of Northwestern Europe. The Baltic makes accessible the lumber and other raw materials of northern Europe, the transatlantic routes radiate from the English Channel to the rich industrial and raw-material regions of the eastern Americas; from the south come the goods of western and southern Africa; a few days' sailing around the Iberian Peninsula brings freighters of the North Sea lands to the great Mediterranean route. This last route is closely connected with the Black Sea, which commands much of the trade of southeastern Europe, and is also connected, via the Suez Canal, with the Indian Ocean route to India and the Far East. Rivers such as the Rhine, Weser, Meuse, and Scheldt, and numerous canals bring the trade of Germany and central Europe to the North Sea ports. These numerous water routes are supplemented by the most intensively developed railway net to be found anywhere in the world.

A Varied Region. The common possession of a stimulating marine climate, mineral resources, dense population, high standards of living, and considerable industrial and commercial development makes Northwestern Europe a regional unit. This unity should not, however, be allowed to conceal the tremendous variety of peoples and resources to be found within the area. Small, but significant, environmental and human differences have caused considerable localization of industries and have been primarily responsible for the tremendous amount of internal trade among the various parts of Northwestern Europe. The division of the area among many nations has also caused the development of many industrial centers which

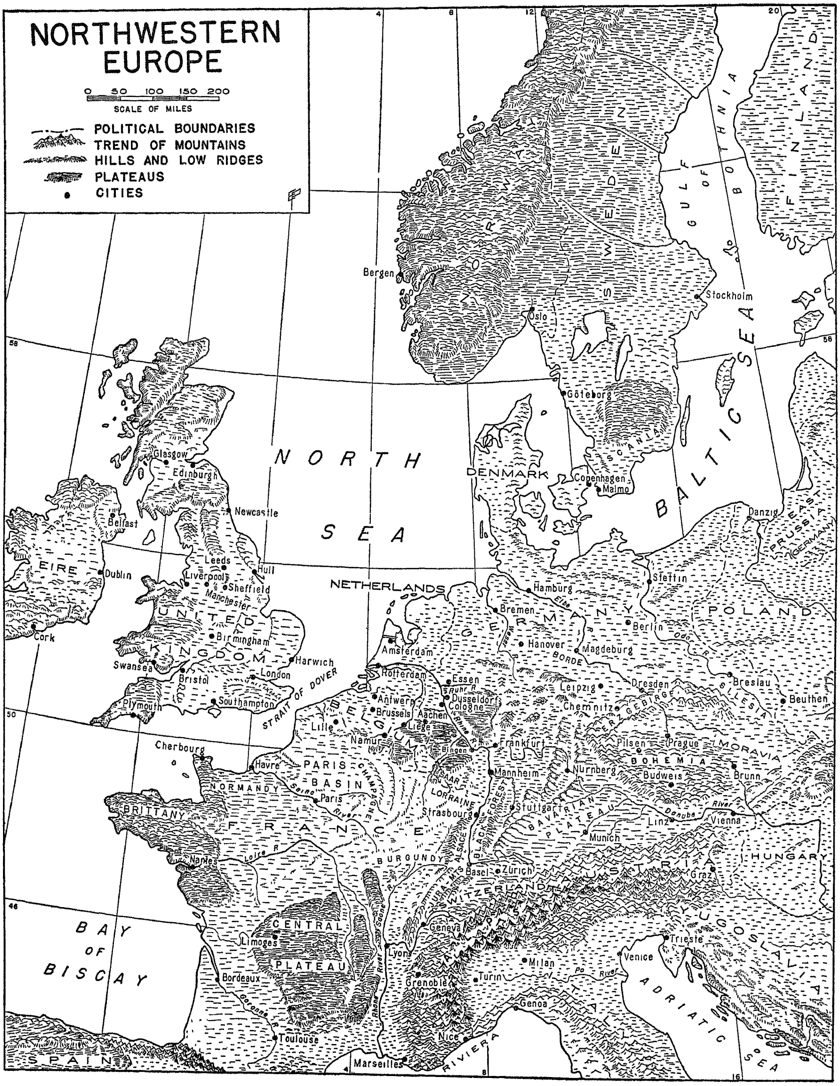


Figure 263. The boundaries are shown as of July, 1939.

would hardly have succeeded but for tariffs and subsidies Commercial and political competition between these nations has been the most important factor in shaping European (and perhaps world) history during the last three centuries. So important is nationalism in European economic life that the following discussion must be on the basis of political units rather than natural regions. Many of the natural regions occur in several of the countries. The combination of natural regions found in each country has often played a tremendous part in the development of national policy for the nature of the regions included largely determines the balance of the economic life of the nation.

The British Isles

The Rise of the British Empire. Until after the Middle Ages the British Isles was a backward area on the edge of civilized Europe. Farming, fishing, and herding supported a small population, and raw materials such as wool, coal, and tin were exported in exchange for the manufactures of the Continent Manufacturing was mostly limited to the production of simple goods for the home market.

After the discovery of the New World, Britain turned to the sea for additional income. Her fishing fleet was an ideal training ground for a growing navy and merchant marine. Colonies were established in the Americas and a foothold gained in India. By 1700 trade with her possessions was a major British industry.

During the sixteenth and seventeenth centuries manufacturing received a tremendous impetus due to increased trade and the immigration of skilled workers. Religious and political persecutions on the Continent caused many artisans to flee to England, where they were welcomed by the government. Among these were the Flemish wool weavers who provided the technical skill and knowledge for the development of the English textile industries. England was fortunate, also, in having inventors who produced a large proportion of the basic inventions underlying the Industrial Revolution. Water power was of major importance at first, but with the invention of the steam engine, England's coal resources became available to industry.

With the growth of manufacturing came a tremendous growth of population. Agriculture, at first, increased because of improved methods but later became subordinate and was finally allowed to decline, for it was found cheaper to import food and export manufactured articles in exchange. Industrial profits were so great during the nineteenth century that large

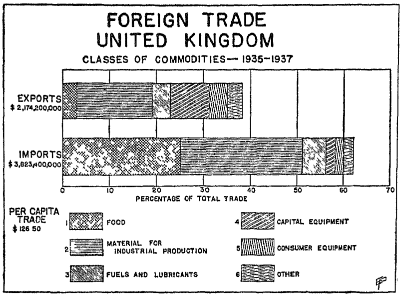


Figure 264 A large unfavorable balance of trade is characteristic of countries with huge investments abroad

amounts of British capital were invested in mines, railways, and even factories in the colonies and foreign countries. During all this period the British Empire grew in area, population, and wealth and provided an increasing market and increasing sources of food and raw materials—all under British control.

The Industrial Revolution soon spread to the Continent and the United States, and the British began to face strenuous competition in many markets, especially from Germany. Often the new industrial areas had the advantages of newer and better machinery and cheaper labor than in the long-established British factories. The World War of 1914-18 further strengthened British competitors. Because of the submarine blockade, raw materials were imported into the British Isles only at a high cost, and exporting was equally expensive. Former British customers turned to the growing industrial areas of the United States, Japan, and Canada for manufactured goods or developed their own industries. After the war many of these new industrial areas continued and even increased their production. The peoples of Canada, Australia, South Africa, and India insisted that their place in the Empire was not to be subordinate to industrial Britain, but that they must develop their own resources. Politically, this feeling led to a demand for and a granting of almost complete independence to Canada, Australia and New Zealand, the Union of South Africa, and the Irish Free State (now Eire). In 1931, the new status of the dominions was indicated by the change of name from the *British Empire* to the *British Commonwealth of Nations.*

The United Kingdom. The area of the United Kingdom is a little less than that of the Middle At-

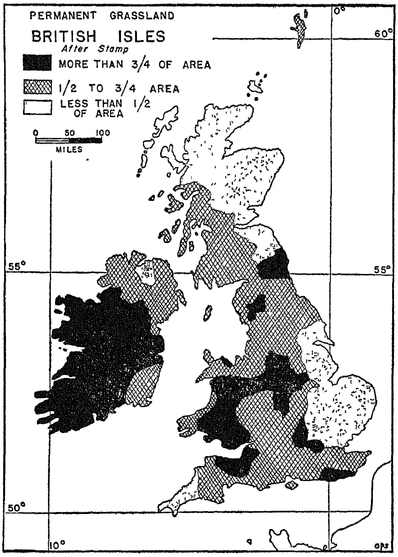


Figure 265. Why is most of the grassland on the western side of the islands?

lantic States (New York, New Jersey, and Pennsylvania). The distance from London to Liverpool is about equal to the distance from New York to Baltimore. From London to Glasgow, Scotland, is about the same distance as from New York to Montreal. As is true of the Middle Atlantic States, which resemble the United Kingdom in industrial development as well as size, the United Kingdom must be subdivided into several topographic regions to understand the distribution of its industries.

If a line be drawn across England from Newcastle to a point on the English Channel to the south of Bristol, it will separate approximately the more humid and more rugged part of Great Britain (on the west) from the drier and less rugged part to the east. The eastern portion, sometimes called the English Plain, consists of alternating chalky ridges interspersed with valleys formed on softer beds of clay. In this region are most of the historic cities of England, such as London, Canterbury, Oxford, Cambridge, York, Norwich, and Newcastle. This is "Green England," a land of farm villages, sheep downs, fishing villages, ports, and small factory towns. Within it the Thames Valley gave the best access to the interior and thus gave London the leadership over the numerous other ports along the indented coastline.

West of the dividing line is a land of old rocks, on top of parts of which lie the coal measures which have so aided English industrial progress. In the valleys are most of the industrial cities of Britain while the highlands which separate them are sparsely populated areas devoted only to sheep-raising, hunting, and the resort trade.

The highlands, although rugged and carved into many striking forms by continental glaciation, are not very high. Ben Nevis, the highest peak in Scotland, rises only to 4400 feet, and Snowden, the highest peak in Wales, only to 3560 feet. The Pennine Chain which forms the backbone of northern England nowhere exceeds 3000 feet, while the Cheviot Hills and Southern Uplands which separate England from the Scottish Lowlands (the Rift Valley of Scotland) are even lower. Despite their low elevations, these highlands are important barriers to communication. Furthermore, their cool climate and thin soils have created vast treeless areas (heaths and moors) which formed the physical basis for much of the British wool production.

Northern Ireland consists of low granite mountains to the west and a plateau of igneous rock to the east. Except in a few broad valleys which specialize in the cultivation of oats, flax, and potatoes, most of this rough land is infertile.

Agriculture. The United Kingdom is overwhelmingly industrial and commercial. England, Scotland, and Wales each have less than 5 per cent of their total population engaged in agriculture, while Northern Ireland has slightly more than 10 per cent so engaged. Another measure of the relative position of agriculture is found in the proportion of the food supply of Great Britain which is imported. In the postwar period up to 1929, it produced, on the average, but 44.9 per cent of its food (including fish) and imported the remainder.

The climate, characterized by considerable rainfall, a low rate of evaporation, cool summers, and mild winters; and the large amount of rough or rolling land are factors more favorable to pasture, hay, and oats than to most field crops. This predominance of grass and the feed grains—plus the growth of root crops such as potatoes, turnips, swedes, and mangels which are used in large quantities for fodder—and the tremendous local market have made the raising of dairy cattle, beef cattle, and sheep of primary concern to farmers.

Wheat and barley are important crops only in the drier lowlands of southeastern England. Oats, because they are better suited than wheat to dampness and predominantly sour soils, are cultivated very widely, although the greatest area of concentration is in northeastern Scotland and the eastern part of Northern Ireland. Potatoes and other vegetables, which are better suited to the cool climate than the grains, are the only items of agriculturally produced food in which Great Britain produces more than half of its consumption (the figure is 70.3 per cent). In dairy products and poultry and eggs, home supplies account for close to half of the consumption.

Figure 266

ACREAGE IN PRINCIPAL CROPS—BRITISH ISLES [1]

Average of 1921-30
(in thousands of acres)

Crop	*Acreage*
Hay	9,319
Oats	3,894
Wheat	1,696
Barley	1,507
Turnips and swedes	1,410
Potatoes	1,175
Mangels	430

[1] After a table in L D Stamp and S H. Beaver, *The British Isles,* p 163. Longmans, Green and Company, London, 1933.

Industrial Regions of the British Isles. Coal fields have had a marked influence on the location of industry and the distribution of population. Figure 267 shows the distribution of the major producing coal fields in the British Isles and the location of the major and minor industrial districts. The relation of all of the major industrial regions, outside of the London district, to the coal fields is apparent. The geography of these industrial regions is outlined in summary form below.

MAJOR REGIONS

I. *The London District.* The development of industry here is based upon the commercial, political, and market factors rather than on local supplies of power or raw materials—although both are readily available by cheap water haul The manufactured products are highly diversified, and include products for local consumption; the manufacture of imported raw materials—such as oil, sugar, cacao refining—and the production of goods using large quantities of cheap or skilled labor. In this district are located most of the branch factories of foreign concerns which have been established to produce within the rising tariff wall. These latter industries, together with the newer ones of

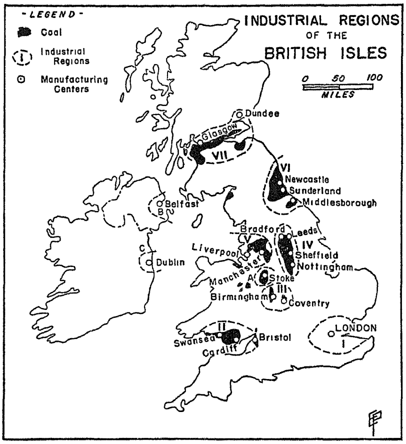


Figure 267. (After U. S Department of Commerce)

rayon, chemicals, and electrical goods, have accounted for the fact that this district has increased its proportional importance in British industrial life.

II *The South Wales District.* This area, unlike the London district, became of importance only after Britain had turned to manufacturing and owes its significance to its wealth of coal and its coastal position Heavy industry, such as iron and steel, and the refining of tin, copper, and zinc based on the local fuel and imported raw materials predominate This is one of the principal shipping points for the export of coal because of its large supplies of excellent steaming fuel The decline of coal export because of the growing use of oil as a marine fuel, together with increasing competition in the heavy industries from other nations, has caused this district to decline in prosperity since the World War

III. *The Birmingham-Coventry District* This district has also increased in its proportional importance in British industry since the war In addition to the heavy iron and steel industry—based on local coal and some local and much imported iron ore—it long since developed a wide diversity of highly fabricated metal manufactures This is probably due in part to the distance from the coast and the higher cost of imported iron ore and in part to its central position which allows it to draw upon a wide variety of semifabricated materials for further manufacture. Munitions, tools, automobiles, bicycles, and machinery are among the more characteristic large industries

IV *The Eastern Midlands.* Here, in the West Riding of Yorkshire, and in eastern Derbyshire and Nottinghamshire, is an industrial area associated with an important coal field, but one that was of considerable importance even before coal was used extensively The woolen industry grew up here in very early times and owed its growth to large supplies of local wool from the sheep of the Pennine mountain chain to the west, the water power of the mountain streams, the excellent soft water for washing and fulling, and the migration of artisans from abroad With the substitution of steam for water power, industry

concentrated on the coal fields. It soon outgrew the local supplies of wool and now depends largely on imported raw materials. Traditional skills, cheap power, and easy access to imported wool are now the basis of the woolen and worsted industries in such cities as Leeds and Bradford The manufacture of textile machinery here is also associated with the growth of the textile industries Local iron ore and the excellent coal were the early bases for the development of iron and steel industries throughout this district, but especially in its southern part. Now, imported iron ore and special qualities of pig iron and steel give rise to the manufacture of high-grade iron and steel products in Leeds, Sheffield, and Nottingham.

v. *The Western Midlands.* The two great industries in this district which centers about Liverpool and Manchester in Lancashire and northern Cheshire are cotton textiles and iron and steel, although there are numerous other industries of importance. The northern part of this district started out to be an important woolen textile area in early times because it had, on the western side of the Pennines, all of the advantages which characterized the West Riding of Yorkshire on the eastern side. However, as soon as cotton became the dominant textile fiber, it took advantage of its relation to the important port of Liverpool—through which the raw material was imported from the American South—to shift to that industry. The competition from foreign countries with growing cotton-textile industries based on cheaper labor, cheaper raw materials, or tariff protection has brought decidedly hard times to the Lancashire towns. In addition, the iron industry, which depends on local coal and imported ore, is largely confined to the heavy products and shipbuilding in which foreign competition has been most serious.

vi. *The Northeastern District.* Here, about the mouth of the rivers Tees and Tyne, is one of Britain's greatest coal and steel centers. Excellent coking coal, large supplies of iron ore from the near-by Cleveland district, and seaboard position facing the markets and iron-ore supplies of the Continent are the outstanding advantages Heavy iron and steel products and shipbuilding center around the mouth of the Tees at Middlesborough, and the shipping of coal and shipbuilding are important at Newcastle on the Tyne. Chemicals and glass and the smelting of imported ores from abroad are also important.

vii. *The Scottish Lowlands.* The lowland which crosses Scotland from the Clyde to the Firth of Forth is underlain by an extensive coal field which, together with small deposits of local ore, gave rise to Scotland's greatest industrial district and area of greatest population density The local ore supplies were soon exhausted, however, and extensive imports were necessary. Heavy iron and steel industries and shipbuilding grew up, especially along the Clyde from Glasgow to the sea and to the southwest in Renfrewshire and Ayrshire. The exhaustion of the best coal seams, the increased cost of mining, and the decline of shipbuilding since the war have left this region in a very depressed state. The cotton and linen textile industries also grew to be important in the Glasgow-Paisley area, but began to decline as early as the latter part of the nineteenth century.

MINOR DISTRICTS

A *"The Potteries."* This region has an excellent coal supply, but surrounding hills isolated it somewhat from supplies of iron ore. The land was poor for agriculture, but did yield considerable quantities of excellent pottery clay. This latter resource is widely distributed in Great Britain but was of especial importance here because the region had little else in the way of resources. The result has been one of the world's greatest china and pottery industries, which has given the district the name by which it is known all over the world.

B. *The Belfast District.* This district of Northern Ireland has long been famous for its linen and shipbuilding industries. Skilled Scotch-Irish labor and local flax were the original bases for the former industry. Much raw material is now imported Shipbuilding arose because of excellent labor, an excellent harbor, and easy access to supplies of semifabricated iron and steel from England and Scotland

Eire (Ireland). This self-governing dominion, until recently known as the Irish Free State, is largely a limestone plain almost entirely surrounded by a rim of low, rugged mountains Glaciation has covered the Central Plain with boulders and glacial clay which have so upset the drainage that lakes and bogs are common. The plain is therefore devoted primarily to the raising of beef cattle rather than to agriculture. Dairy-farming, swine-raising, and subsistence farming are the common occupations on the better-drained soils, which are most common in southern and southeastern Eire. The hilly lands often specialize in sheep-raising.

Trade. Until recently, nine-tenths of the trade of Eire was with the United Kingdom. Exports of beef cattle, butter, pork, and liquors were exchanged for the manufactures and coal of the United Kingdom. Quarrels between the governments of the two countries have decreased this trade. At present, the Irish government is attempting to lessen its dependence on the United Kingdom by encouraging manufacturing and a more diversified agriculture.

Industrial Centers. In a much smaller way, Dublin's industry has a character similar to that of London. The city is the capital and largest center of population of Eire. Added to its traditional distilling and brewing industries are those—such as cigarettes, boots and shoes, clothing, and the assembly of motor cars—arising from the new tariff barriers about the new nationalistic Eire. Cork, in the southeast of Eire, has similar industries for similar reasons.

QUESTIONS FOR DISCUSSION

1. If the countries of Northwestern Europe were united politically, would the foreign trade be greatly increased or decreased? Why? Would many of the industries be relocated? Would such a union, on the whole, be advantageous to the people of Europe?
2. What economic difficulties make it hard for Eire to attain complete independence from the United Kingdom?
3. Why was "free trade" a popular policy in Great Britain in the nineteenth century? Which sections of England were anxious for the repeal of the Corn Laws?

CHAPTER 47

CONTINENTAL NORTHWESTERN EUROPE

Dependence on foreign trade is a characteristic of all Northwestern European countries. The United Kingdom, the Scandinavian Countries, the Low Countries, and Switzerland all have an annual foreign trade of over $125 per capita. On the other hand, France and Germany have less than half as much foreign trade per capita, partly because of the greater variety of their industries, and partly because of the military necessity for greater self-sufficiency.

Even France and Germany are dependent on foreign sources for many essential commodities. When France was the enemy of the United Kingdom, it attempted to extend its control over the continent to obtain its needs. Now that Germany is blockaded by English sea power, German policy is based on expansion in central and eastern Europe.

France and Switzerland

The economy of France differs greatly from that of the United Kingdom. Although French foreign trade is important, it is not absolutely necessary for France's existence. France can feed its people if necessary, and is, perhaps, as self-sufficient as any advanced area of similar size. France has a small population in proportion to its resources when compared with its neighbors—Italy, Germany, and Belgium. It also owns extensive colonies, mostly mediocre in quality, which are far less vital to its well-being than those of the United Kingdom. Its population is almost static, which contrasts with the rapidly growing populations of Italy and Germany. Consequently, the French are quite satisfied with their present possessions and their main anxiety is to maintain the *status quo.*

Northern France. The economic as well as political center of France is the Paris Basin which includes most of northern France. Paris is the center of a series of concentric ridges, alternating with lowlands. The inner part of this basin which extends to the English Channel is a rich agricultural center producing wheat, sugar beets, and dairy products. Other parts of the basin include pasture lands, infertile areas which have been left in forest, and the sunny slopes used to produce the well-known wines of Champagne and Burgundy.

Paris. Most of the Paris Basin is drained by the Seine River and its tributaries. Several of these valleys converge near Paris and thus make it the logical commercial center for northern France. Here converge all the rail, canal, river, and highway routes of France which bring varied raw materials and semimanufactured goods to the workshops of Paris and its suburbs. Most of the industries owe their importance to leadership in styles. This prestige arose from the cultural leadership of the French court which attracted artists of all kinds to Paris. The clothing, jewelry, furniture, perfume, automobile, art goods, and printing industries lead at present. Paris is also an important political, commercial, financial, tourist, and educational center.

Industrial Regions around Paris. To the northwest of Paris is the industrial region of Picardy, Artois, and French Flanders. The ports of this area, Havre, Rouen, Amiens, Dunkirk, and Calais, handle most exports from the Paris Basin. Coal, from extreme northern France, is carried by canal or rail to a multitude of industrial cities which produce woolen goods, laces, linen, and other textiles. Skilled labor rather than coal, however, accounts for the textile industries in this area.

To the east of Paris is Lorraine, a hilly region with large deposits of iron ore. Here are most of the heavy metallurgical industries of France. East and southeast of Paris in Alsace are numerous cotton-textile mills as well as chemical industries based on local potash deposits. Southeast of Paris in the Rhone-Saône Valley are numerous cities which manufacture a great variety of goods, including fine silks, iron and steel, machinery, and munitions.

The Central Plateau. South of the Paris Basin is the Central Plateau, a poor highland area in which pastoral activities are gradually replacing the raising of potatoes, barley, and rye. Roquefort cheese is one of the best-known products of the highland area. In

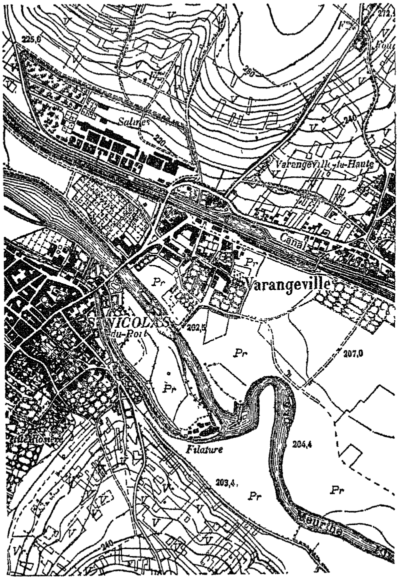


Figure 268. For military reasons, most European countries have been mapped in great detail This shows a part of northeastern France (near Nancy) on a scale of 1/20,000.

many of the narrow valleys which penetrate deep into the plateau, numerous small industrial cities have developed, using local water power, cheap rural labor, and, largely, imported raw materials. The largest of these cities are Limoges (Haviland china), St. Etienne (munitions and metals), and Clermont-Ferrand (rubber products).

Southern France. A ring of level fertile agricultural lands almost surrounds the Central Plateau. Grapes are the most characteristic crop, but wheat and corn are also widespread. Southern France, adjoining the Mediterranean, is the greatest wine-producing region in the world, although its wines are inferior to those of the north. Except in this one-crop grape region, the agriculture of southern France is very intensive and highly diversified.

The Aquitaine Basin. The lowland to the west of the Central Plateau is known as the Aquitaine Basin, a region which rivals the Paris Basin in agricultural importance. The place names of this region read like a wine catalogue—Bordeaux, Medoc, Sauterne, Cognac, and others. The port of Bordeaux is noted for its wine exports.

The Rhone-Saône Valley. The very narrow lowland to the east of the Central Plateau is occupied by the populous Rhone-Saône Valley. Although its soils were formed from rich alluvial and lacustrine deposits, this lowland is noted as a commercial highway and industrial center rather than as a rich farming region. Lyons (Lyon), a manufacturing center of 600,000 inhabitants, lies at the junction of the Rhone and the Saône. The raising of silkworms in the surrounding countryside was the basis for the foundation of silk manufacturing, and Lyons is today the leading silk center of Europe. Nîmes, Avignon, and other cities also manufacture silk, clothing, and small metal products. These industries have prospered here partly because of the hydroelectric power generated in the Alps and the Central Plateau, the small local deposits of coal and iron, and the plentiful skilled labor. Probably more important than these advantages, however, has been their location on the through route from Marseilles, the busiest French port, to Paris.

Peripheral Rugged Areas. The rugged areas which remain to be described, although picturesque, are of minor economic importance. The coastal position and infertile soils of the low but rugged Armorican Plateau of Brittany have almost limited its people to fishing and stock-raising. In the more fertile spots, orchards and truck gardens have developed because of the mild marine climate.

On the southeastern border of France are the rugged Juras and the higher, snow-capped French Alps; these mountainous lands are suited only for grazing, hydroelectric power, and the tourist industry. Where the Alps reach the Mediterranean, they form a rugged, precipitous coast known as the Riviera. Its south facing slopes have even in the winter a mild climate which attracts numerous tourists. Due to the climate other industries are the cultivation of flowers (both for cut flowers and perfume) and early vegetables.

On the southern border, the Pyrenees form an effective natural boundary. Economically, their importance is small. The main industries are sheep-raising and self-sufficient agriculture.

Foreign Trade. French exports are largely luxury goods, including wine Many French imports are tropical and subtropical raw materials (cotton, rubber, silk) or goods which can be obtained more cheaply abroad than at home. A generally unfavorable balance of trade is offset by interest payments and the tourist

trade. However, the bulk of French economic life is based on home production and home markets; thus France is the last major country to be seriously affected by world depressions.

Switzerland. This beautiful country is so well placed among the progressive countries of Europe that it has none of that cultural backwardness usually associated with mountainous areas. Much of Switzerland is a continuation of the Alps and Juras of eastern France and resembles them in scenery and occupations. The most highly developed area is the Swiss Plateau which separates the Alps from the Juras The rough lands of this area are more suited to dairying than field crops—hence the important cheese, milk-chocolate, and condensed-milk industries. Water power is available in the near-by mountains, and has been used to develop industries that require skilled labor, power, and but little raw material. The Swiss watch industry is based on the mechanical skill of the farmers of the Jura Mountains who have little farm work to do during the winter months. Other Swiss industries include textiles, aluminum, optical goods, printing, and machinery.

For centuries the Swiss have lived at peace with their neighbors. Their ability to get along with all nations has made their country an international center. The pleasant hospitality of the Swiss has helped their tourist industry to grow beyond that of other sections with equally beautiful scenery.

QUESTIONS FOR DISCUSSION

1. How would you expect the trade of Le Havre to differ from that of Marseilles? How does French foreign trade differ from that of: the United Kingdom, the United States?
2. Examine Fig. 263 How has the relief of France influenced its military history?
3. The Belfort Gate is a pass between the Saône Valley and the Rhine Valley. Do you think this pass is of great commercial value? Why?

Germany

Germany's economy is in many ways intermediate between that of the United Kingdom and France. Until about 1870 Germany was primarily an agricultural nation; since then Germany has placed increasing dependence on industry. Because Germany was late in securing a colonial empire, Germans were forced to develop markets and sources of raw material in neighboring European countries German science and skill have given German goods an enviable reputation and almost every neighboring country buys more from Germany than it sells in return.

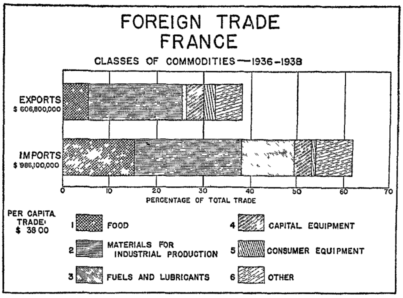


Figure 269 Compare this graph with those for the United Kingdom (Fig. 264), United States (Fig. 219) and Canada (Fig. 217)

The Northern Plain. Germany is divided into geographic belts which run roughly east and west. Across northern Germany extends a glaciated, sandy, infertile plain, which is better suited for pine forests or grazing than for farming. Intensive cultivation and fertilization has made these lands suitable for cereals (especially rye) and for potatoes used for hog feed Dairy cattle are also important in the damper regions near the coast. The large cities on this plain are important because of their general position rather than because of the surrounding plain. Hamburg on the Elbe, Bremen on the Weser, and Stettin on the Oder are important sea and river ports and handle large quantities of goods en route to central Europe. Berlin was originally selected as a political capital largely because of its central position in relation to the Kingdom of Prussia. It has since grown to be an important manufacturing and commercial center. Its industries —clothing, printing, and others—are characteristic of Paris, London, and New York, as is also its production of high-grade electrical goods.

Between the plain and the highlands of central Germany is the most highly developed section of the German Reich It forms a rough crescent extending from the Belgian border at Aachen (Aix la Chapelle) to the former Polish border at the Silesian industrial city of Beuthen. Minerals, fertile soil, a stimulating climate, an energetic and skilled people, and a central position enable this entire area to support more than two hundred and fifty people per square mile on a fairly high standard of living.

The Westphalian-Lower Rhine Industrial District. This district has the best position and local resources of any German industrial area. Here are the

Figure 270. This map shows the excellent net of waterways which intersects this economic center of Northwestern Europe. The map exaggerates the importance of German iron deposits (From the *Geographical Review*, April 1924, published by the American Geographical Society)

coal mines of the Ruhr Valley, and iron ores are found just south of the coal fields. Iron ore from Sweden and Spain, and other foreign raw materials, are brought up the Rhine via Dutch ports. Railways, canals, and rivers connect with markets throughout Northwestern Europe and with foreign markets via the ports of Rotterdam, Amsterdam, and Bremen. This is the true industrial heart of Germany for the bulk of her manufactures are produced here.

The center of the heavy industries is Essen (650,000 inhabitants) with its Krupp steel furnaces and rolling mills. Some ten additional cities of over 100,000 population surround Essen and produce a great variety of goods, including glass, chemicals, textiles, machinery, and hardware. Throughout the Ruhr Valley one city crowds onto the next, and factory chimneys are rarely out of sight.

The Wupperthal (Wupper Valley) just south of the Ruhr is especially noted for its textiles and dyestuffs. Duisburg-Ruhrort, where the Ruhr joins the Rhine, is one of the leading river ports of the world. The ancient city of Dusseldorf is a noted hardware center. Cologne (Köln), a commercial center of 740,000 people, manufactures pottery, chemicals, paper, machinery, lace, and Eau de Cologne. The industrial development of this region is so diversified that there are

very few manufactures which are not produced there.

The Börde. This word, which in German dialect means "fertile plain," is an area of loess soil around Magdeburg. This loamy soil, often equal to a chernozem in fertility, is much richer than the sandy areas to the north, and an intensive agriculture employing sugar beets, rye, wheat, barley, and potatoes is therefore practiced. Close by (at Stassfurt) is the world's largest deposit of potash. The section as a whole represents as great an application of science to agriculture as can be found. The cities are occupied mainly with commerce in and the processing of agricultural products. Brewing, sugar refining, and flour milling are characteristic industries.

Saxony. Originally, the industries in this section were based on water power and the mineral deposits in the adjacent Erz Gebirge (Ore Mountains). Small coal fields were also present and large deposits of lignite have more recently served as a power source. The ore deposits are almost exhausted, but the skill of the workers makes Saxony one of the most industrialized and densely populated areas in the world. Industries of all kinds—provided they involve skill rather than the presence of raw materials—are found in the area. Textiles, Dresden china, books, scientific instruments, and leather goods are characteristic products. The central position of Saxony has given it a strong hold on the markets of central Europe; the skill and originality of its workers attract buyers to the Leipzig Fair from all parts of the world.

Bohemia. This district is a continuation of the Saxon industrial area, although its products are often somewhat poorer in quality. Most of the exports (70 per cent of which are manufactured articles) reach world markets through German ports, although an important quantity is also shipped to the agricultural countries of the Danube. Bohemia was the industrial center of the old Austro-Hungarian monarchy. Since the World War, it has progressed rapidly by adopting American methods of large-scale production. It is well supplied with raw materials, such as coal, iron, leather, and wood pulp; but must import wool, flax, cotton, and many other materials needed in its industries.

The plains of Bohemia and Moravia are important farming areas, both as sources of food for the industrial towns and for the export of beet sugar. Hops and cereals used in the brewing of beer (the names Pilsen and Budweis are well known) are also important farm products. Slovakia is likewise a farming area but, compared with Bohemia, it is retarded in its development. Lumbering is also important there.

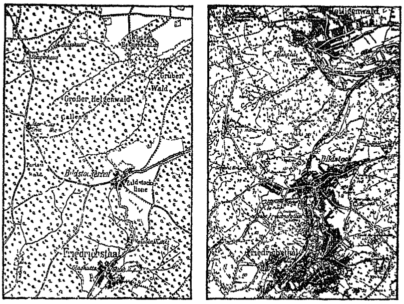


Figure 271. Two maps of the same area in the Saar Basin to show the growth of towns resulting from the Industrial Revolution. The map to the left is dated 1818, the other 1913. (After an exhibit at the Museum fur Länderkunde, Leipzig)

Silesia. The crescent of industrial activity and dense population which lies north of the Central Highlands of Germany from Aachen on the Belgian border to Silesia—where Germany, Poland, and Czechoslovakia formerly met—continues on as far as the Russian Ukraine. Silesia, German before the World War of 1914-18 and now German again, is rich in coal, lead, and zinc and also has some iron ore. This has resulted in industrial development, especially in the metallurgical, woolen goods, and linen industries. The soil in the industrial region is fertile and easily provides food for the industrial population. Breslau, the largest city, is an important industrial and commercial center which derives some of its importance from its position as a German outpost on the edge of Slavic Europe.

The Central Highlands. The highlands of central Germany extend from the Belgian border to the plains of Bohemia. They are not high but are sufficiently rugged and barren to form a boundary between the Prussians and the south Germans. Their cities have been important cultural centers and have produced such German leaders as Luther and Goethe. Several river valleys, of which the Rhine is outstanding, cross the highlands, and along these routes many industrial and commercial towns developed. Local minerals (zinc, copper, and iron), wood, and leather provided raw materials for industrialization. As in Saxony, local raw materials are exhausted or unimportant today, but industries, such as toy making, which involve considerable skill and imagination, are still the principal occupations.

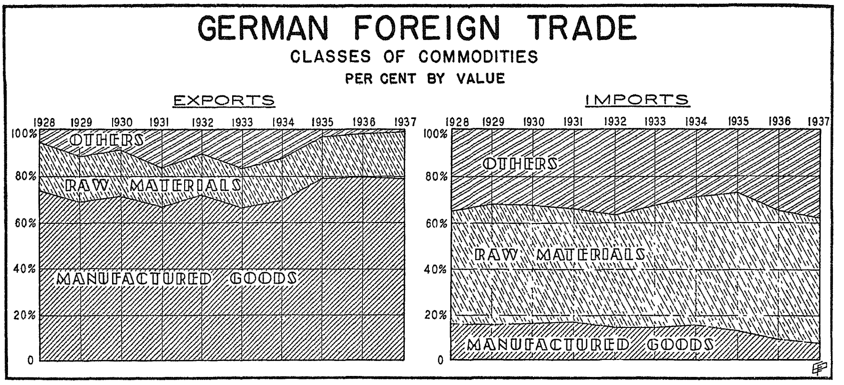


Figure 272.

The Rhine Valley. To most Germans the Rhine Valley stands for Germany, for in addition to its beauty and its legends, it is the commercial artery which connects northern and southern Germany. Going up the Rhine from the Dutch border, the traveler passes through the North German Plain, the Ruhr district and thence to the important commercial cities of Dusseldorf and Cologne (Köln). The number of boats and chains of barges on the river is striking. Above Cologne the river and its valley narrow as the Central Highlands are crossed. The wine grapes which occupy the sunnier hillsides are almost the only product. South of Bingen the valley again widens and is joined by the extensive Main Valley. Near this junction is Frankfurt-am-Main, the leading commercial city of south central Germany. Here several routes through the Central Highlands join the route through the Main Valley which connects with the Danube and its valley. The Rhine Valley continues southward and its routes tap the trade of the Swiss Plateau. Other routes from Frankfurt lead westward to Paris and the North Sea. One of these routes crosses the Saar Basin, an important coal area which has recently been returned to Germany.

Southern Germany. The topography of southern Germany is varied. In the south the Swiss Plateau continues across the Rhine as the Bavarian Plateau; the Swiss Alps continue into Austria and gradually become lower and less rugged to the east. West of the Bavarian Plateau is the Black Forest (Schwarzwald), a wooded mountain area whose resorts attract tourists from all of Europe, and beyond it is the fertile trough of the Upper Rhine Valley. North of the Black Forest and northeast of the Bavarian Plateau the valleys of the Neckar and the Main stand out conspicuously on a detailed population map.

The Upper Rhine Valley. This district, with rich alluvial soils on its river terraces, is one of the most prosperous agricultural areas of Germany. Its climate is mild, and crops unknown in most of Germany are common. Grapes and wine are the principal products, but wheat, corn, hops, tobacco, vegetables, and fruit are also important.

The Main and Neckar Valleys. These broad areas of alluvial flats and rounded hills have well-kept forests and farmlands which supply four large industrial and commercial centers. On the River Main, close to where a canal joins that river with the Danube, lies Nürnberg, famed for its toys, paper, textiles, and electrical supplies; near the mouth of the Main is Frankfurt, a noted commercial and banking center which possesses numerous light industries. On the Neckar, Stuttgart, cultural center of Württemberg, manufactures textiles, books, leather, and chemicals, while Mannheim, the great river port at the junction of the Neckar and the Rhine, manufactures machinery, chemicals, and dyestuffs.

The Bavarian Plateau. This area is not overfertile and much of it is in pasture, forests, and peat bogs. The poor agricultural resources encouraged many of the peasants to develop small home industries to supplement their income. Basketry, textiles, embroidery,

paper, and glass were among the manufactures started in this way.

Munich (München), located where the Vienna-Basel route crosses the route from the Brenner Pass to central Germany, is the industrial, commercial, educational, and political center of Bavaria. It is known for its university, its art, and its manufacture of textiles and scientific instruments.

Austria. The Austrian economic system was developed when Austria had political and commercial control of the Austro-Hungarian Monarchy with its 51,000,000 people. Vienna (Wien), located where the north-south routes crossed the Danube Valley, grew into a great political, commercial, and educational center. Its cultural and political leadership during the century following the Congress of Vienna (1814-15) extended far beyond the Austro-Hungarian boundaries. After 1918 Vienna lost most of its hinterland and its 2,000,000 inhabitants found insufficient employment in serving the needs of the 4,500,000 people in other parts of Austria. Austrian manufactures found difficulty in reaching their former markets because of the tariff barriers and government-subsidized industries in the new states of central Europe. Wood products, animal products, and a variety of small manufactures were the principal exports.

It is too soon to predict the economic effects of the *Anschluss* with Germany. The German market may help to absorb Austrian manufactures; on the other hand, the mountainous areas of Austria can contribute iron ore, lignite, salt, electric power, and lumber to the German industrial system. The Alps also provide a recreation area which has long been popular with German tourists.

The German Economy. Germany with mediocre resources has succeeded in maintaining on a high standard of living 50 per cent more people than France. The secret of German success has been in widespread education and in the application of this education to agriculture, industry, and trade. The emphasis on foreign trade has made Germany's position a precarious one, for, as the World War demonstrated, a tight blockade of Germany is possible. Partly for this reason, German policy aims at self-sufficiency and the maintenance of close economic and political relations with adjacent countries. It is unfortunate that history and temperamental differences have prevented the development of close and friendly relations with France, for these two countries are complementary to each other in resources and products.

QUESTIONS FOR DISCUSSION

1. Compare the three major powers of Northwestern Europe as to agriculture, manufacturing, commerce, raw materials, and balanced economic system.
2. Germany is often referred to by Germans as a "Thoroughfare Land" Why? How is the central location of Germany an advantage? How a disadvantage?
3. With the aid of an atlas, plan a sixty-day tour of Northwestern Europe, including a visit to as many types of industrial, commercial, and agricultural centers as you can Note distances between cities and compare them with distances in northeastern United States.

The Low Countries

These small countries have an importance far out of proportion to their size. Both are densely populated, both handle considerable transit trade, and both engage in intensive agriculture, but otherwise they are quite different.

Netherlands. The Netherlands (low lands) is located at the mouths of the Rhine and Meuse rivers, hence much of the trade of Germany goes through Dutch ports. This transit trade has given the Netherlands fifth place among the nations in foreign trade and seventh in the size of its merchant marine. The control of colonies (especially Netherlands Indies) which are much larger in area and population than the homeland has also contributed to Dutch trade. The income from commerce is supplemented by fishing and by an intensive agriculture which produces specialized products, such as cheese and bulbs, for export Except for clay and a small coal field in the south, mineral raw materials are lacking. Nevertheless, manufacturing—especially the processing of imported raw materials—is very important.

Belgium. Belgium, on the other hand, is fairly well supplied with mineral raw materials including coal, iron, zinc, lime, and glass sand. Thus, the heavy industries have become of major importance and have remained important even though many of the raw materials are now imported. Coal is shipped in from Germany, iron ore from Lorraine, copper from Belgian Congo, and other ores from a variety of countries. The heavy industries are located in the hilly country of the south and east at Liége, Namur, Charleroi, and Mons. This region is near the coal fields and other mineral deposits. On the plains of Flanders have developed many light industries of which the most important is the long-established textile industry. Flax has long been grown in Belgium and provides the raw material for the linen and lace industry. Huge imports of wool and cotton supply the other textile industries. Considering its many-sided indus-

trial development, it is little wonder that it has been called the "Workshop of Europe." Closely connected with industry is its intensive farming which is often carried on by industrial workers or their families. A close integration of urban and rural life is a characteristic of the Belgian economy. Belgian commerce is important, but the transit trade is much smaller than that of the Netherlands. Antwerp (Anvers or Antwerpen), the dominant port, is on the Scheldt, a small river which is connected with central Europe only by canals.

Luxemburg, a small, hilly country between Belgium and the Saar Basin, is joined with Belgium in a customs union It contains part of the Lorraine iron field, and exports large quantities of iron ore and pig iron.

The Scandinavian Countries

These three kingdoms are closely tied up with the United Kingdom and Germany in their economic life. To both of these countries the Scandinavian countries send raw materials and foodstuffs, and receive coal and manufactured goods in exchange. Nevertheless, the Scandinavian countries are not backward, as is so often the case with raw-material-producing regions, but are among the most progressive nations. They have few resources, but they have used them unusually well.

Denmark. Denmark is predominantly agricultural. In 1937, 80 per cent of its exports were classified as foodstuffs. Its soil is a mixture of sand, chalk, and glacial clays in the better areas, elsewhere it is often infertile sand. Much of its soil, although mediocre, was better than that of adjacent northern Germany so that the Danes found it worth while to raise cereals for the German market. The competition of cheap American wheat and changes in the German tariff forced the Danes to turn to intensive stock raising. Through cooperative organizations, they have produced unusually high-quality butter, ham, bacon, pork, and eggs The yield per acre in terms of value of the product is as high as anywhere in the world. Fodder crops are raised, but large quantities of fodder (oil cake, corn) are also imported to supplement the local supply. Scientific stock raising, nearness to the market, and good salesmanship have made a prosperous Denmark. Fishing, commerce, and highly specialized manufacturing also contribute to the Danish income.

Norway. Norway is largely a barren mountain high land with a subarctic climate. A small area in the southeast is warm enough for forests and pasture, but most of Norway is barren. Narrow lowland areas along the fiorded Atlantic coast have provided a foothold for numerous fishing towns, whose boats provide the country's major export—fresh, smoked, and canned fish. The other major source of income is also from the sea. Norwegian tramp steamers and sailors are found the world over. During the World War, Norway lost eight hundred ships, but the profits of carrying trade were so great that the great loss did not disturb Norwegian prosperity.

Sweden. Sweden occupies the lowland part of the Scandinavian Peninsula. A variety of resources has enabled Sweden to develop a better-balanced economy than its neighbors. In the extreme south is a plains region (Scania) which is similar in development to Denmark. Extending across Sweden from Gothenburg (Goteborg) to Stockholm is a lake region which is the industrial heart of Sweden. Water power, lumber, and iron ore are available resources. These, and imported coal and minerals, have been used for the manufacture of matches, paper, tool steel, chemicals, machinery, and electrical apparatus. As in much of Northwestern Europe, the skill of the people has been somewhat more important than the mere presence of raw materials.

The northern two-thirds of Sweden is largely undeveloped except for lumbering in central Sweden and the important iron mines in arctic Sweden. Very little of these raw materials enter into Swedish industry, for they are usually shipped to Germany or the United Kingdom directly from northern ports.

QUESTIONS FOR DISCUSSION

1. Name a European manufacturing area which resembles each of the following American manufacturing areas: New England, New York metropolitan area, Pittsburgh, Detroit, Montreal.
2. Compare Switzerland and the Netherlands, pointing out similarities and differences.
3. What geographic factors explain the ability of Norway, Sweden, Denmark, the Netherlands, and Switzerland to keep out of the World War of 1914-1918?
4. Trace or purchase an outline map including France, Germany, the Netherlands, and Belgium. Subdivide the area into small regions based on similar utilization of resources Which regions occur in more than one country? Explain the location of each region
5. How might industries be redistributed if a United States of Europe, without tariff boundaries, were to be established?

CHAPTER 48

EASTERN EUROPE AND ASIATIC RUSSIA

Compared with Northwestern Europe, this region is backward in development. Today, however, it is an area of rapid change and much progress, for powerful incentives have caused the people of eastern Europe to attempt to catch up economically and culturally with their western neighbors. The overthrow of autocratic government in Russia and the rise of a militant socialistic state have revolutionized Russian economic and social life. In other eastern European states, the aftermath of the World War was an outburst of nationalistic feelings accompanied by many reforms. Many new nations were formed, and their peoples are making strenuous attempts to equal the national cultures of Northwestern Europe. Eastern Europe is progressing rapidly today, both because there is such great need for improvement and because its peoples have the will to make the necessary reforms.

Why have the nations of eastern Europe been so slow in their development? Undoubtedly the political factor has been largely responsible. Long after the people of Northwestern Europe had settled down to urban life, eastern Europe was subject to nomadic invasions. Huns, Finns, Avars, Bulgars, Magyars, Mongols, and Turks were the principal invaders within historic times, and these probably represent but the last of a constant stream of peoples which have crossed the plains of eastern Europe since the advent of primitive man. Few natural barriers aided the defense of eastern Europe. Each nomadic horde found conquest easy and, in turn, was for the same reason easily conquered by the next invader. Gradually, however, the settled peoples of eastern Europe acquired the culture and weapons of the West, and with these tools were able to defend themselves from nomadic invaders. Nevertheless, it was not until 1480 that Russia was freed from Mongol control, and the retreat of the Turks in southeastern Europe did not start until 1683. Even then, learning, wealth, land ownership, and political control remained in the hands of a small, conservative ruling class which believed that its security depended upon the slow arrival of progress, if, indeed, it came at all.

The Environment and Economic Development

The physical environment also contributed greatly to this lack of progress. In contrast to Northwestern Europe with its diversified relief, eastern Europe is a region of extensive plains, broken only by a few mountain ranges—the Urals, the Carpathians, and the peripheral mountains of the Balkans. The significant differences in the environment from one part of the region to another are largely those of climate, soil, and vegetation, and these changes are very gradual. Thus, each community found its products similar to those of its neighbors for miles around and such uniformity was not conducive to the early development of extensive trade.

Climatic conditions are much more extreme than in Northwestern Europe. The following table of cities (all about 52° N.) shows how the temperature range becomes greater toward the east:

Figure 273

City	*Longitude*	*Mean January temperatures*	*Mean July temperatures*	*Mean annual range*
London, England	0°	38.7° F.	62.8° F.	24.1° F.
Berlin, Germany	13° E.	31.3°	64.6°	33.3°
Warsaw (Warszawa), Poland	21° E.	25.9°	65.8°	39.9°
Saratov, U.S.S.R.	45° E.	11.5°	72.1°	60.6°
Orenburg, U.S.S.R.	55° E.	3.4°	70.9°	67.5°

The total amount of rainfall decreases from west to east and the dependability of the rainfall decreases even more rapidly. The snows of winter melt late in the spring, the rivers are flooded, and the poorly drained plains often become a morass of thick mud. Later, the high temperatures cause rapid evaporation and, if the summer rains are poor, serious drought follows. Especially in the northern half, the severe continental climate is too cold for much work in winter, animals and men spend most of their time indoors, roads are blocked by snow, and ice-bound rivers are closed for navigation for nearly half the year. A good summer season brings a bountiful harvest, but the peasant is often far from a good market for his surplus and the local price of grain is low.

Mineral resources are not lacking, but iron ore and coal, the basic industrial minerals, are not so common or, in general, so high in quality as in Northwestern Europe. The prevalent low relief and the low rainfall limit the potential water power. In petroleum resources, eastern Europe far surpasses Northwestern Europe, which has almost none of this essential industrial fuel and lubricant. Platinum, manganese, and chromium are plentiful in the U.S.S R. In general, it is the human factor rather than lack of minerals which has retarded industrialization in eastern Europe, for, even where supplies are not limited, it was unusual, until recent years, for the available resources to be utilized.

Numerous lakes, swamps, and areas of poor soil have been created by glaciation in the northern half of this region. The glaciers have rounded off relief features which were originally but slight. The top soil has often been carried away by the glacier, leaving barren rock outcrops, boulder deposits, and many swampy areas. Lakes are common, and so slight is the relief that canals can easily connect the lakes and rivers. On the other hand, the southern half of the region is generally an area of good agricultural soils similar to those of the better parts of the Heart of North America. Except for the small rugged areas which begin rather abruptly amid the plains, the land is generally flat and ideal for large-scale, mechanized agriculture.

Certain economic handicaps are characteristic, except in a few progressive centers. Labor, both agricultural and industrial, is unskilled, inefficient, and usually illiterate. Wages and standards of living are very low and many of the peasants buy little that is not obtained by barter in their own community. Except in Hungary, the peasant class makes up more than three-quarters of the population. Transportation facilities are slow and inadequate, trade is small, and but a small part of the total produce goes to world markets. The exports are generally foodstuffs and raw materials, the imports are tools and manufactured articles for consumption. Until the postwar period, manufacturing within eastern Europe was largely concerned with the processing of raw materials, handicraft industries, and the manufacture of low-grade textiles and clothing Recently, economic nationalism, caused partly by fear and partly by the loss of foreign markets, has given rise to a host of new manufactures.

Unoccupied lands and unrealized natural resources are also a characteristic of the region. In Finland, northern Russia, and Siberia, pioneers are still occupying new lands Even in Hungary, good farmlands, formerly used for grazing, are now being tilled for the first time. Unlike those of other parts of Europe, the natural resources here remain largely unutilized.

The economic contrast between Eastern and Northwestern Europe can be clearly seen by comparing statistics for several countries typical of each area:

Figure 274

Country	*Per cent employed in agriculture*	*Exports (per cent of total)*		*Foreign trade per capita*
		Raw materials and food	*Manufactures*	
United Kingdom	6	21	63	$129
France	38	29	59	68
Germany	29	19	70	60
Poland	76	70	22	12
Hungary	58	71	28	22
Russia	87	86	14	6
Yugoslavia	80	92	7	12
Rumania	80	75	25	12
Bulgaria	82	99	1	12

Buffer States of the Baltic

The states which border the Baltic Sea from Poland to Finland are transition lands between Northwestern Europe and Russia. The western parts of these states are often as well developed as similar areas in Northwestern Europe, but rapid changes are encountered as one travels eastward. Politically these states are also transition lands, for their existence depends largely on German and Russian good will.[1]

Poland. The Poland of 1918 to 1939 was a revival of an old kingdom which was partitioned during the eighteenth century among Austria, Germany, and Russia. Polish economic development is uneven because of the varied former ownership. Former German Poland is as advanced as adjacent Germany, former Austrian Poland is almost as progressive, but the bulk of Poland, formerly Russian territory, is retarded in every way except in a few industrial and cultural centers such as Lodz and Warsaw (Warszawa) These industrialized cities were once the major manufacturing area of the Russian Empire and attained this development because they were near the industrialized section of Europe and at the same time within the Russian tariff wall.

Physically and economically, Poland is largely a continuation of Germany. The northern plains produce rye, potatoes, cattle, and hogs and—in more fertile areas—wheat, barley, and sugar beets in addition. The industrial cities of Poznań and Bydgoszcz have industries similar to Magdeburg—flour mills, breweries, and sugar refineries. Eastward, in former Russian Poland, the plain is poorly cultivated, crop yields are but half those in the west, and much of the land is pine forest or swamp The area near the Russian border is occupied by the Pińsk and other marshes and is sparsely inhabited—an ideal boundary between two unfriendly states

As in Germany, the area between the mountains of central Europe and the northern plains is the most highly developed section. Silesia has all the raw materials necessary for the development of heavy industries. Coal, lead, zinc, limestone and an inadequate supply of low-grade iron ore are available locally, while in the northern foothills of the Carpathians there are good supplies of lumber, petroleum, salt, and lignite. The headwaters of the Oder and the Vistula (Wisla) reach south toward the Danube through a pass called the "Moravian Gate" which gives good access to the markets of the nonindustrialized Danubian countries, while a fairly good railway net leads to the markets of Poland and eastern Germany. Silesian coal as well as manufactures are exported. The coal is near the surface and is so cheaply mined that it can compete with British coal in the markets around the Baltic Sea, in spite of the high costs of overland transport. Coal is also sent to the Danubian countries and Italy.

Much of Poland is as yet undeveloped, but it has excellent natural resources, a population of 31,000,000, and a position between Germany and Russia which is significant. The capital, Warsaw, is centrally located in relation to the resources, where the east-west route crosses the Vistula Valley. Much of Poland's foreign trade is carried on with her southern and western neighbors, especially with Germany which imports Polish foodstuffs and raw materials. Ocean routes are reached via the port of Danzig and the new Polish port of Gdynia. The exports via the Baltic are foodstuffs, coal, lumber, and zinc. The imports are largely raw materials (cotton, rubber, iron ore), fertilizers, and manufactured goods.

The Baltic States. Estonia, Latvia, and Lithuania are small farming states with an environment similar to that of Denmark Since the World War, they have given increasing attention to the production of butter for the English market These countries and the adjoining parts of Russia and Finland are the world's leading flax-growing area. They also produce rye, potatoes, and sugar beets, largely for local consumption This area handles a profitable transit trade from central Russia because its ports are ice free much longer than Leningrad.

Finland. This northern country is larger than the United Kingdom, but has less than one-tenth as many people. Two-fifths of the country is waste land, one-half is forest land, and most of the remainder is almost equally divided between farmlands and pasture. The fertile areas are close to the southern coast where most of the people live. Glaciation scraped bare much of the old rocks of the Finnish shield and formed some 35,000 lakes, many of which are used for transportation and as reservoirs for power projects.

The Finns are an ambitious people, and, because of strong Swedish influence, more advanced in western European culture than other eastern European peoples. Limited resources force them to turn to lumbering as their principal industry. The forest products, which make up four-fifths of their exports, are carefully prepared for market and are shipped as

[1] The description which follows is based on conditions in July, 1939. After any major political readjustment, such as is taking place in this area, it is impossible to describe present conditions because of the rapidity of economic changes

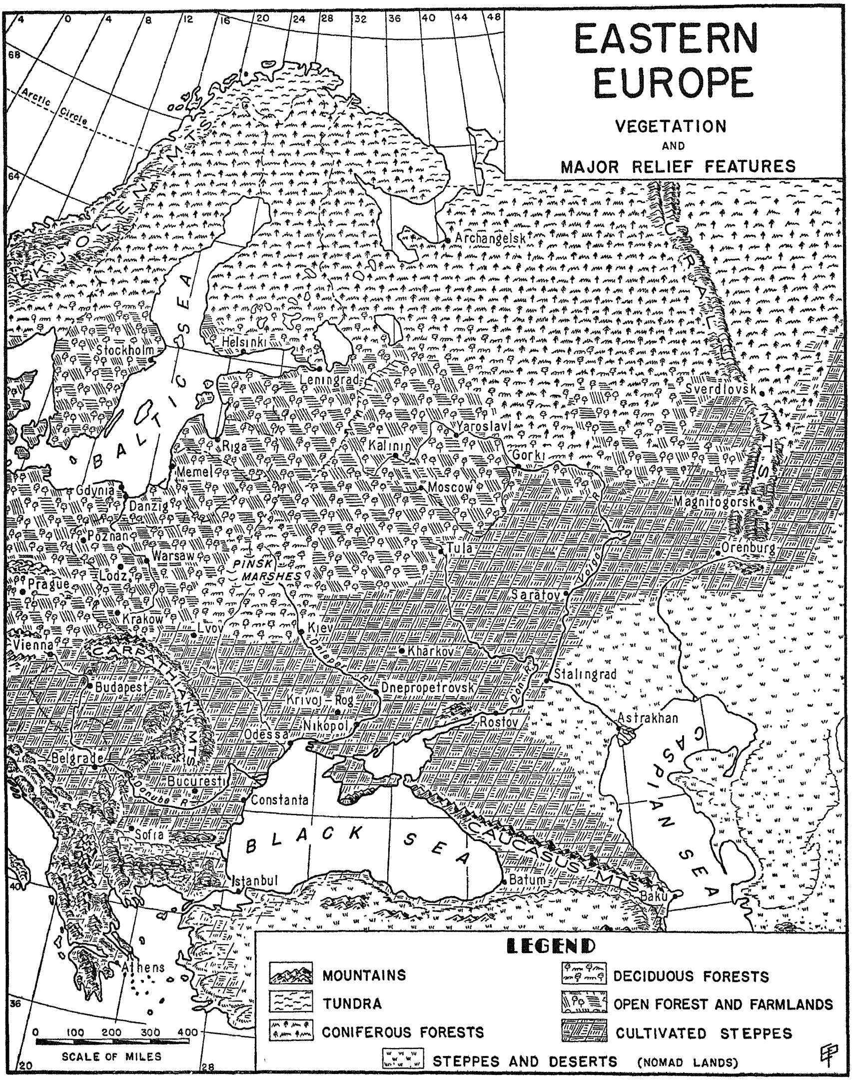


Figure 275. Most of the 1938 political boundaries (indicated by broken lines) are likely to be changed.

sawn lumber, wood pulp, paper, and wood manufactures rather than as raw lumber. Recently, the Finns have turned to intensive dairying, and Swiss-type cheese "made in Finland" is now obtainable in American markets. The cool climate decidedly limits the crops which can be raised (barley, oats, potatoes, rye, sugar beets, hay) so that a large part of the Finnish food supply must be imported.

QUESTIONS FOR DISCUSSION

1. Which of the present characteristics of eastern Europe are permanent and which are likely to change as the result of further economic development?
2. Why has Finland developed in spite of its northern latitude (which is very similar to that of Alaska)?

The Union of Soviet Socialist Republics (Russia)

Nearly one-half of Europe and an even larger area in adjacent Asia is under the rule of the Soviet Union. Russia's 170,000,000 people outnumber the combined populations of the United Kingdom, France, and Germany This vast land with tremendous man power has resources adequate to make Russia as self-sufficient as any country in the world. Sparsely inhabited and with huge undeveloped resources, Russia is now engaged in transforming a medieval economy into an ultramodern socialistic state.

After the expulsion of the Mongols, Russia was a weak, isolated, semi-Oriental state. Peter the Great (1672-1725) gave great impetus to the expansion and Europeanization of Russian culture. He established the city of St. Petersburg (now Leningrad) on the Baltic and made it his capital. His military forces continued the territorial expansion of Russia east, west, and south from the former center around and to the east of Moscow (Moskva). Russian traders crossed the Urals as early as 1580, but the real occupation of Siberia did not begin until after the Napoleonic Wars. At first it was largely a convict camp, but, after 1860, large numbers of settlers entered Siberia voluntarily. Meanwhile, the upper class of Russians acquired the culture of western Europe and directed the trade and diplomacy of Russia to fit into the economy of the European powers. The peasants (serfs until 1858) were illiterate, poverty-stricken, and very much under the domination of a landlord class.

The Bolshevist Revolution (1917) changed the entire orientation of Russia. For several years following, the Russian Government was blockaded and at virtual war with the Allied Powers. Russia was forced to rely on her own resources and the new government made strenuous attempts to attain self-sufficiency. After peace was reestablished, Russian raw materials, such as petroleum, lumber, and wheat, were dumped in European markets to obtain the foreign exchange necessary to buy the machinery for industrialization. The industrial raw materials of Russia and Siberia were developed, and extensive plans were made for an adequate railway system. The political and economic center was changed to Moscow, a more suitable location than Leningrad for the capital of a self-sufficient Russia. The government encouraged, by heroic measures, the spread of education and the introduction of power machinery as a substitute for hand labor. Even the small peasant farmsteads were combined and converted into large collective farms, tilled as much as possible by machinery.

The belted nature of Russian geography is clearly indicated by Figs. 262 and 275. Of the two northern most regions (Arctic Eurasia and the Northern Coniferous Forest) nothing need be added to the discussion on page 390. The major part of the Russian economic life is located within the region of Agricultural Lands, which is continuous from eastern Europe across Siberia. Throughout its length, most of this agricultural belt can be conveniently subdivided into two subregions—the Open Forest and the Cultivated Steppes—equal in area and importance.

The Open Forest. South of the Northern-Coniferous-Forest region, the landscape becomes more varied. Glacial moraines add low, rounded hills to the monotonous, rather swampy lands of the northern plains. Oaks, beeches, lindens, elms, and maples gradually replace the conifers. Summer temperatures are warmer, the growing season is longer, and the soil is better decomposed and contains more humus. Natural pasture lands occur within the forest, and the closely packed short trees of the north are replaced by the larger, but more scattered, trees of the Open Forest. Extensive forest clearings contain fields, meadows, and the wooden huts of the peasants.

The people of the Open Forest equal in number the population of France. Here was the homeland from which the Russian people expanded eastward into Siberia and southward over the steppes. In the summer the peasants labor on their farms which produce more rye and flax than those in any other part of the world. Other crops—such as potatoes, hay, and sunflower seed—are important, but, on the whole, farming is not so diversified or so scientific as in similar plains areas in Germany, or even Poland. Dairy

cattle, oxen, and sheep are found about every village, but they are carelessly bred and small in size. Hogs are fed on scraps and the mast of the forest The forested lands play a large part in the life of the peasant: in the winter, as hunting grounds and the source of wood for fuel, building, and wood carving; in the summer, for gathering mushrooms, wild honey, and berries.

Industrialization. The agricultural and lumbering resources are hardly adequate to support the large peasant population. The Czarist Government encouraged the development of peasant industries—such as leather working, wood carving, homespun textiles—to provide employment and income during the long, dreary winter. When factories were built in this area about the end of the last century, many of the peasants worked in them during the winter months. The raw materials for the large Muscovite industrial area are provided by coal, iron ore, and phosphate deposits to the south of Moscow; local clay, lumber, flax, leather, and wool; minerals from the Urals; as well as foreign products imported via the Baltic. Peat, water power, and even wood supplement coal as sources of power. The concentration of railways, canals, and the upper branches of the Volga River in this central region favored the cheap transportation of its products to the Russian markets.

The Communist philosophy is, perhaps, better suited to an industrialized urban state than to a country of peasants. Hence, the Soviet Union has placed considerable emphasis on industrialization, and it was but natural that much of this development should take place about Moscow, the Soviet capital. The growth of a political bureaucracy and the simultaneous increase in industry caused a rapid development of many industrial centers located within several hundred miles of Moscow. The capital became the largest textile center of Russia, and also produced large quantities of clothing, shoes, furniture, hardware, trucks, pottery, and bricks. Ivanovo-Voznesensk rivals the capital in textile manufacture. Maxim Gorki (formerly Nizhni Novgorod), long known as the trading center of the Upper Volga, became an important producer of automobiles, tractors, and machinery. Likewise, the metal manufactures of Tula, the machinery industries of Kalinin (formerly Tver), expanded rapidly. In the north, Leningrad, with its easy contacts with Northwestern Europe, specialized in complicated goods requiring considerable engineering skill—such as scientific instruments. Other northern cities produced paper, cardboard, and wood pulp.

The Ural Area. Another industrial center grew rapidly in the Open-Forest Area around the Ural Mountains. These mountains are low and almost insignificant as barriers, but in the variety of their mineral deposits they are unequaled. The Ural Area has long been known for its platinum and emeralds, its iron and other industrial minerals have been exploited spasmodically since the sixteenth century. But pre-Soviet Russia was more interested in developing the western regions nearer to Northwestern Europe This factor and the lack of good coking coal greatly retarded the development of the Urals. Now that Russia has decided to become a Eurasian (rather than a European) power, the Ural Area is centrally located in relation to the agricultural areas of European Russia and Siberia. In addition, its strategic position away from the border appeals greatly to a country which for a decade expected an attack from the capitalistic powers.

Iron, manganese, copper, chromium, silver, gold, platinum, zinc, lead, asbestos, bauxite, potash, salt, sulphides, low-grade coal, lignite, lumber and water power make up a remarkable list of Ural raw materials. Coking coal is now brought 1400 miles from the Kuznetsk coal fields north of the Altai Mountains of Siberia. Sverdlovsk, Magnitogorsk, and several other cities have developed not only as metallurgical centers for all Russia, but as commercial and manufacturing centers for Siberia.

The Cultivated Steppes. The grass-covered plains, or Cultivated Steppes, make up the southern half of the Agricultural Lands. On the northern border of this area large quantities of oats, hemp, tobacco, and sugar beets are raised in a densely populated, intensively farmed area. On the steppes the cereals, wheat, barley, rye, and—in the south—corn are the dominant crops. This rich area of chernozem soils is similar in climate, soil, and relief to the wheat belts of north central United States and adjacent Canada. In the days of antiquity, Athens supplemented its food supply by importing grain from the northern shores of the Black Sea. In spite of long use, the fertility of its black soils has not been exhausted. Farming methods are generally crude and yields are one-half those in the American wheat belts. This is the region where the huge model state farms and collective farms have been established by the Soviet Government. The level fields are ideal for large-scale, mechanized agriculture, and tremendous increases in yield have followed the replacement of crude plows by tractors. Horses, sheep, poultry, and cattle are also an important part of farm-

ing, but, as in central Russia, these animals are large in number but poor in quality and size.

Minerals and Manufacturing. Mineral resources, less varied than in the Urals but better suited to heavy industries, underlie many parts of the steppes. The Donets Basin coal field, averaging two hundred miles in length and twenty-five miles in width, is about fifty miles northeast of the Sea of Azov It contains large, easily accessible coal deposits of many grades—including anthracite and coking coal. One hundred to one hundred and fifty miles to the west are the large Krivoj Rog iron ore deposits (60 per cent to 65 per cent iron content), the Nicapol manganese deposit, and the gigantic water power development of Dneprostroy (540,000 horsepower). To the southeast of the Donets Basin are the oil fields, found on both sides of the Caucasus Mountains, and north of the mountains are ores of lead, zinc, and manganese. Salt deposits cover the northern shores of the salty Caspian Sea, and iron ore is found on the Kerch Peninsula which almost separates the Sea of Azov from the Black Sea. Metallurgical industries were developed by foreign capital over the coal fields, along the Dnepr River (especially at Dnepropetrovsk) and around Krivoj Rog. All of these industries have been greatly expanded by the Soviet Government.

Other cities of the steppes produce a variety of manufactures for local consumption in addition to processing agricultural products. Kiev, Kharkov, Rostov, Odessa (wheat-exporting port), Saratov, and Stalingrad (tractors) are all important political, commercial, industrial, and agricultural centers.

Siberia. Siberia is, environmentally, but a continuation of European Russia and differs from it mainly in the greater severity of the climate, greater isolation, and more retarded development. Its development is not colonial in nature and it is today considered as an integral part of Russia.

The backbone of Siberian exploitation is the belt of chernozem soils, first used by the land-hungry peasants pushing eastward. This rich-soil belt, at first accessible only by river or the crudest of mud roads, was later followed by the Trans-Siberian Railway. Where rail and road routes crossed main streams, cities developed such as Omsk on the Irtish River and Novo-Sibirsk on the Ob River. Settlements also developed along the rivers to the north and south of the railroad, and were connected with it by steamer services But between these routes lie vast, almost uninhabited areas without any means of sending their produce to the market.

Transportation and sparse population are the great Siberian problems, Siberia has an area 60 per cent greater than that of Continental United States, yet its population and railroad mileage are less than those of New York State. Its resources are so great that it would not be surprising if the eastward expansion of the Russian economy during the next century should duplicate or surpass the westward expansion of the American economy during the nineteenth century.

Although the belts which characterize the geography of European Russia continue across Siberia, each is subdivided by relief features running roughly north to south. The first is a great plain which extends for 1000 miles from the Urals to the Yenisei River, and which contains valuable and fairly well-settled forest, farm, and pasture lands in its southern half, though its northern half is so swampy that it is almost uninhabitable. Only in winter, when its marshes are frozen, is this area exploited for its furs.

East of the Yenisei is a rugged block which slopes from the high Altai and Sayan mountains in the south to the low swampy plains which extend along most of the arctic shores. Much of this mountainous area is inhabited only by primitive hunters and fishers; important Russian settlements are found only in the valleys near the Trans-Siberian Railway. This area is valuable for its minerals On its southwestern border are huge deposits of coking coal in the Kuznetsk Basin. Silver, gold, iron, copper, and other minerals are found near Krasnoyarsk and in the Altai, and the crystalline and volcanic nature of the rocks suggests that other rich deposits will be uncovered when the area is thoroughly prospected

The Lena Valley forms a basin which separates the uplands of central Siberia from the eastern mountains. It is inhabited mainly by Yakuts, a Turkish people who live by cattle raising, hunting, fishing, and primitive farming. The Russians in the valley are gold miners, government officials, and exiles. This area is noted for having the most extreme range of temperature found anywhere on earth

East of the Lena Valley, Siberia extends 1500 miles to Bering Strait. This is a sparsely settled region, occupied only along the streams and coasts by primitive peoples whose manner of life roughly resembles that of the Eskimos The lack of development can be seen by the size of the towns: Sredne-Kolymsk, a "city" whose location is marked on even small atlases, has less than 600 people, and other towns are usually much smaller.

South of Lena Valley and east of Lake Baikal

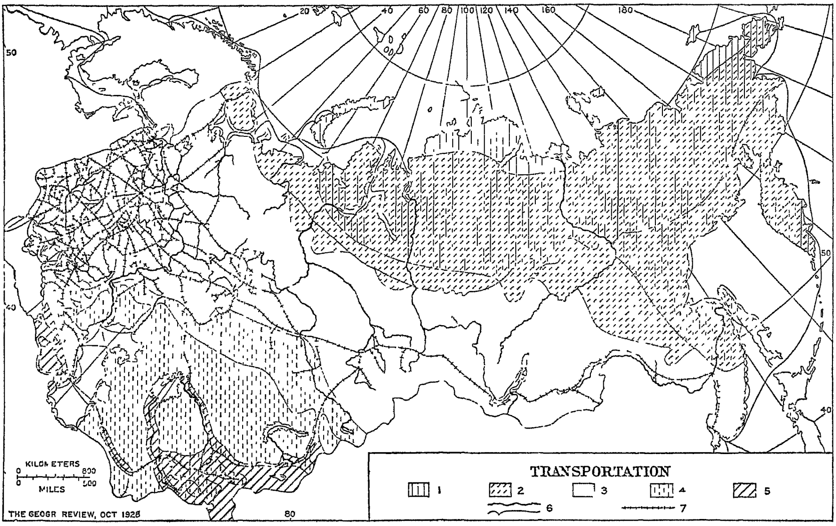


Figure 276. Means of transportation in the U S S R 1. Dogs; 2. Reindeer, 3. Horses and oxen; 4. Camels; 5. Mules, asses and buffaloes; 6 Principal lines of navigation on rivers and seas, 7. Railways (Courtesy of the *Geographical Review,* published by the American Geographical Society)

is the drainage basin of the Amur River. The plains of this area, equal in agricultural potentialities to the farmlands of central Russia, have been occupied by Russian settlers Timber is being cut and exported to Japan, and the adjacent mountains are known to be rich in minerals. Here then is another Siberian area which seems destined for great economic development, though, as is the case in many other parts of Siberia, isolation from European Russia has so far delayed progress.

Turkistan. South of the agricultural lands are the Nomad Lands of Eurasia which include the only subtropical areas under Russian control. The oases of Turkistan are Russia's hope for independence from foreign cotton, silk, and other subtropical products. The present Soviet policy is to encourage these areas to specialize in those crops which only they can produce. This policy is being applied, not only to Turkistan, but less strictly to all of the Soviet Union. It is the greatest attempt to apply economic geography that the world has seen. If this geographical division of labor is to succeed, Russia must have a much more efficient and foolproof transportation system. Soviet economic planners are fully aware of this and the building of the Turkistan-Siberian Railway and the double-tracking of the Trans-Siberian Railway and other trunk lines are but the first steps in overcoming the tremendous distances involved in Soviet internal trade.

The Soviet Trade and Economy. All foreign trade is under strict government control and is so regulated as to supply what the Soviet leaders believe to be the current needs of the Russian economy. Imports vary, therefore, with changes in government policy. Exports must be maintained or increased to pay for imports which the government considers necessary. Exports largely consist of foodstuffs and raw materials, the imports, at present, of capital goods and raw materials needed to build up Soviet industry. If the Soviet philosophy is rigorously applied, foreign trade should decrease when the industrial system is able to build its own machinery and supply most consumer needs. Thus Russian industrial expansion should represent, not a threat to the markets of other industrial countries, but simply an advance in Russian standards of living.

QUESTIONS FOR DISCUSSION

1. What economic activities would you see if you journeyed from Hamburg to Vladivostok via Warsaw, Moscow, and the Trans-Siberian Railway? Account briefly for each industry Would you see a greater variety of industries if you traveled from Leningrad to the Black Sea? Explain.
2. What factors help and what factors hinder the attempt of the Soviet Union to become self-sufficient? Would an economic union with Brazil help? How?
3. Compare Russia and the United States as to site and position.

The Danubian States

The four remaining countries of eastern Europe have their economic life centered around the lower Danube Valley. The bulk of their exports either ascend the river to the industrial sections of Germany, Austria, and Bohemia or descend to the ports of the Black Sea. An important railway trunk line, the route of the Orient Express (Vienna, Budapest, Belgrade (Beograd), Sofia, Constantinople (Istanbul)), passes through three of these countries

In environment (similar to the American Corn and Winter-wheat belts), these countries are fairly homogeneous; in diversity of race, language, religion, and political aims, they contain as great a mixture as can be found almost anywhere in the world. Hungary, with its paper currency printed in six languages, is the most homogeneous of these polylingual nations A checkered history of war, diplomacy, and persecution of minorities has given the Balkan Peninsula the name "the powder keg of Europe." So many wrongs, past or present, remain to be righted or avenged that any spark may start a war or revolution.

Hungary. The most progressive of these nations, Hungary, is at present the most dissatisfied. Formerly, Hungary occupied all of the Hungarian Plain and the mountain slopes to the north and east. The treaty of Trianon left Hungary with less than one-third of its former area and 40 per cent of its former population Many Hungarians were placed under the rule of the Rumanians, Slovaks, or Yugloslavs—all peoples whom the Hungarians consider their inferiors. Like Vienna, Budapest lost much of its hinterland. The mineral and forest resources of former Hungary now belong to its neighbors and Hungary's outlets to the sea are through the lands of unfriendly peoples.

The fertile Hungarian Plain is the extremely level bottom of a former shallow inland sea. It is a natural grassland, similar in climate and vegetation to the prairies of Iowa and Nebraska. Until the last century it was largely pastoral and, even today, animal products are as important as crops in the exports of Hungary. Farming, especially in the southeast, is backward, although far superior to the peasant farming on the Russian steppes. Large estates, cultivated extensively by wage laborers, cover much of the cultivated lands with a fairly high degree of intensity. Between the towns are large areas of fertile soil which are occupied only by shepherds and herdsmen. This inefficient distribution of the population is attributed to the former necessity of living in groups for purposes of defense against Turkish attacks.

Corn, winter wheat, rye, sheep, cattle, swine, and poultry are the principal commercial products of the plain. In some areas, specialized crops such as hemp, sugar beets, and wine grapes (Tokay) are grown, but the few conventional crops seem to be preferred by most of the peasants and landlords. A redistribution of the land and a better knowledge of farming might make this region into an area of prosperous corn-belt-type farms. But, on the whole, the eastern European peasant is conservative and his ways are hard to change.

The major feature of the almost featureless Hungarian Plain is the low mountain range, the Bakony Wald (Bakony Forest), which crosses northern Hungary and divides the plain into two unequal parts. The smaller northern part is the more progressive, probably because of German influence. Budapest, on the Danube just south of the gorge through the Bakony Wald, is a gay, progressive city, Germanic rather than Eastern European in appearance. It is at the focal point where the roads and railroads of the southern part of the plain come together to pass through the mountains. Budapest's huge flour mills are among the largest in the world. It also has a variety of other industries, which, encouraged by high tariffs, are attempting to make Hungary—a purely agricultural land if there ever was one—into a partly industrialized, self-sufficient state.

Rumania (Roumania or România). After the World War, Hungary's eastern neighbor obtained a large slice of her territory, including the Transylvanian hills and mountains with their salt, gold, lumber, and other raw-material resources. This rugged area, which now is almost the center of Rumania, has rather subdued topography and is not so much of a barrier as it appears on a generalized relief map.

The Rumanian people claim to be descended from Roman colonists and speak a much modified Latin language. During the nomadic invasions of the plains, they took refuge in the mountains of Transylvania where they led a pastoral life. Not until the nine-

teenth century did they begin to occupy the fertile plains of eastern Rumania. Here, large villages were established around deep wells. Around these settlements vegetables, grapes, and fruit are intensively cultivated, while most of the land between the villages is devoted to the extensive cultivation of cereals.

The eastern foothills of Transylvania contain one of the major oil fields of Europe. Most of the oil is refined and exported through Constanta, on the Black Sea, whence it is shipped to the markets of southern Europe and the Near East. Oil, corn, and wheat make up the bulk of the exports of eastern Rumania, and some lumber and livestock are exported from Transylvania

Agrarian reforms since the war have broken up many of the large estates with an unfortunate effect on the exports The smaller fields, poorer implements, poorer seeds, and careless methods of the new peasant proprietors have decreased both the quality and quantity of the wheat crop. In the long run, this division of the estates should lead to a more intensive agriculture with larger yields; but, as almost everywhere in Eastern Europe, practical education in farming is greatly needed by the peasants.

Yugoslavia. This kingdom is diversified in peoples and resources. Most of the people are members of three closely related groups—the Serbs, Croats, and Slovenes—but there are also considerable numbers of eight other groups concentrated in various parts of the kingdom. Unfortunately, the dominant Serbian group does not get on well with the more progressive Croats, Slovenes, Hungarians, and Germans who were formerly under the rule of Austria-Hungary.

The northern part of Yugoslavia is the southern part of the Hungarian Plain—a fertile area devoted to corn, hogs, winter wheat, and cattle. To the west of this area is Slovenia, a rugged area similar in environment and development to the peaceful mountain valleys of southern Austria. This is the most progressive part of Yugoslavia. With its cultured populace, forested hillsides, vineyards, dairying, and manufacturing, it reminds one of Northwestern Europe rather than the Balkans.

Southern Yugoslavia is hilly or mountainous. Although rich in forests, minerals, water power, and fertile valleys, it is poorly developed, for this territory was only surrendered by the Turks during the nineteenth century and the extreme south was Turkish until 1912. Sheep and goat raising is the most widespread industry. Hogs are found in the north, but not in the south which contains a considerable Moslem population—as is suggested by the many veiled women and the frequent mosques. Tobacco, grapes, plums, mulberry leaves (silk), corn, and wheat are the principal crops, but only part of the good farming land is occupied.

Yugoslavia is isolated from the Mediterranean in the south by a strip of Greek territory. Her territory extends to the Adriatic, but the Dinaric Alps and the Karst Plateau form a barren, extremely rugged barrier which is crossed by but few roads or railways Hence, Yugoslavia's trade was largely Danubian in the past. Recent progress has tended to broaden Yugoslavian economic relations and to erase much of the backwardness which the term "Balkan State" formerly implied. Many new roads, railways, power plants, and mines have been opened, and the cities, formerly Oriental towns, are now modern in most respects

Bulgaria. The most intensively farmed and most densely populated area of Bulgaria is the limestone plateau just south of the Danube. In fertility, crops, and density of population it closely resembles the Russian steppes adjoining the Black Sea To the south are the subdued, forested Balkan Mountains, largely occupied by shepherds and lumbermen. Between these mountains and the similar Rhodope Mountains is a series of basins and valleys through which passes the route of the Orient Express. This fertile area has not been fully occupied since it was surrendered by the Turks. Irrigation is needed in many places and drainage in others. The Tundzha Valley just south of the eastern Balkan Mountains is the world's leading producer of attar of roses. In the other valleys, grapes and tobacco are much more common than wheat, corn, and barley—the characteristic crops of the northern plateau.

Bulgaria is a poor country of hard-working peasants, owners of small farms. Methods of agriculture are primitive and the peasants buy little from the outside world. Tobacco. corn, wheat, eggs, lambskins, and attar of roses are the principal exports. Bulgaria typifies what all of Eastern Europe was a century ago —an agricultural area with primitive methods, low standards of living, and little foreign trade.

QUESTIONS FOR DISCUSSION

1. What products are produced in important quantities by all the Danubian countries? What products are produced in limited areas? Explain.
2. The railways of northern and western Yugoslavia center on Budapest and Vienna rather than on the capital, Belgrade. Why? Is this a handicap to Yugoslavia?
3. The Danube is an internationalized river. To which countries is this fact of greatest importance?

CHAPTER 49

THE MEDITERRANEAN REGION AND THE NEAR EAST

The Mediterranean region, because of its topography and peculiarity of climate, represents a fairly complete geographic unit. It has been the scene of some of the most important events of history, but with its complete settlement it entered a period of stagnation from which it has but recently begun to emerge. In the days of Phoenician, Grecian, and Roman civilizations, the western basin represented an expanding market and a wealth of raw materials. Then, extensive commerce and development flourished. There was an abundance of harbors, and shipping and trade were important throughout the two-thousand-mile length of this inland sea. Growing populations and declining subsistence forced these earlier civilizations to turn their attention inland. Later civilizations—like the commercial cities of Venice, Florence, and Genoa—looked to the Orient for their trade, and great caravans carried silks, spices, and other precious goods from India and China to the eastern end of the Mediterranean, from whence the vessels of the merchant princes brought them to western Europe. Today, the Mediterranean is an important link in the water route across the Eastern Hemisphere, thanks largely to the Suez Canal. As in eastern Europe, its countries are imitating the cultures of Northwestern Europe and making progress in agriculture, industry, and trade.

The countries of the Near East have always been closely allied with the Mediterranean civilizations. For the most part they are arid and semiarid lands whose sedentary cultures are based on irrigation. The crops and temperatures in these countries are similar to those of the Mediterranean area, and Near Eastern trade routes usually touch the Mediterranean at some point. Consequently, there has generally been little difficulty in making cultural and commercial exchanges between the two areas. The Near East has, for centuries, been under the retarding influence of Islam. But, since the World War, Near Eastern leaders, notably Kemal Ataturk, late dictator of Turkey, have introduced many Western ideas. If the present rate of westernization continues, another century may destroy most of the distinctions between the Near Eastern and European cultures

The Mediterranean Environment

Boundaries. The Mediterranean region, as considered here, includes those countries whose relations are primarily with the Mediterranean Sea trade Portugal, although an Atlantic country, is included because of its similarity to adjacent Spain. Many of the countries discussed in this chapter contain considerable areas which are not Mediterranean in trade or climate. Northern Portugal, northwestern Spain, and northern Italy are, in environment and products, similar to Northwestern Europe, but these countries are discussed here as a whole because, as was explained on page 393, national unity is more important than geographic unity in explaining the present economic development in Europe. The Near East is an elastic term, but is taken here to include those western Asiatic countries whose trade outlets are through the Persian Gulf, the Mediterranean, and Black seas rather than through the monsoon lands. Thus, Iraq, Arabia, and Persia are added to the countries around the Mediterranean.

Topography. The Mediterranean Sea consists of a western and an eastern basin. The former separates Africa from western Europe and lies on either side of the 40th parallel, while the latter (eastern), bisected by the 35th parallel, separates Africa from southeastern Europe and Asia Minor Each of the two basins is approximately 1000 miles in length. The dividing line between the two basins is in the vicinity of Sicily and the tip of the "boot" of the Italian peninsula.

The western basin is simpler in form and almost entirely circled by mountains. The Atlas Mountains of Africa and the Sierra Nevadas of Spain inclose the southern and western sides while the Pyrenees, the Maritime Alps, and the Apennines complete the circuit. The mountain chains are approximately parallel

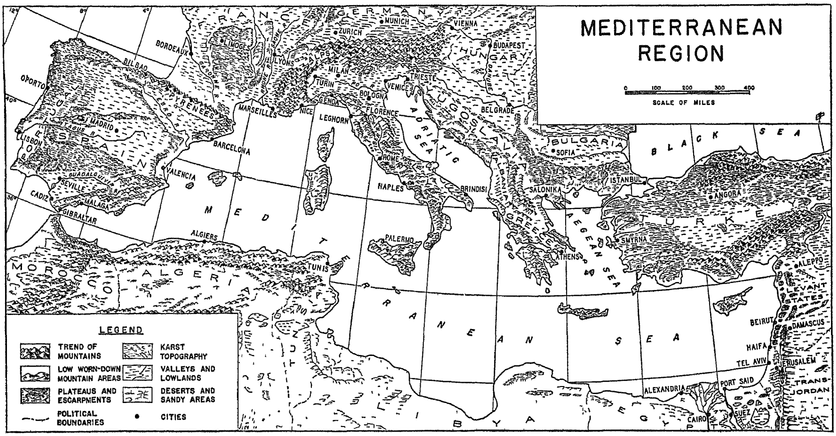


Figure 277

to the coast lines and the coastal lowlands are relatively narrow, even at their widest.

The eastern basin differs from the western in that mountains are present only on its northern side. It also contains a much greater expanse of water.

The mountains of the Mediterranean are rather rugged and often barren. Volcanic activity is common. The plains and valley floors occupy but a small part of the whole area and are generally divided into small units. These small and sheltered valleys were ideal, protected centers for incipient civilizations. All of these areas had access to the Mediterranean and, as their industries grew, they could find convenient markets across the unifying sea.

Climate. Three general features characterize the climate around the Mediterranean Sea:

1. Rain falls freely in the winter half of the year.
2. Summer is a period of relative drought.
3. The annual range of temperature is small.

However, these general conditions are often modified in individual areas. A few important areas in Mediterranean countries (northern Italy and eastern Greece) have considerable rain in summer, Egypt has practically no rain at any season. While the annual range of temperature is generally small, it increases greatly from west to east. Countries such as Turkey often experience extreme winter and summer temperatures, although the extremes are not so great as those in eastern Europe.

Winter is the best season of the year in the Mediterranean lands. It is the rainy season, the growing season, and the season that attracts the tourist from the countries to the north. In the autumn the cyclonic storms of the prevailing westerlies travel far enough south to reach northern Spain, southern France, and northern and central Italy. Heavy rainfall accompanies these disturbances and four inches of rain in twenty-four hours is not uncommon. The number of rainy days is few, however, although the volume of the fall is large—thirty-one inches having fallen at Nice in sixty-seven days. The dry streams turn into torrents, the earth becomes saturated, and vegetation begins to revive. This is the prelude to the delightful season which follows and which accounts for the popularity of the French and Italian Riviera as a winter vacation center. Although there is a secondary maximum of rainfall in the spring, it does not reach the proportions of that of the earlier part of the season.

In the eastern basin, the rains begin in October and continue through to December when they reach their maximum and decrease through the spring. The sun is brilliant and, although it may be cloudy during a cyclonic disturbance, the atmosphere rapidly clears and the sun shines again with increased brilliance through the air which has been washed clean of its dust.

Although protected by the mountain rim, frost and

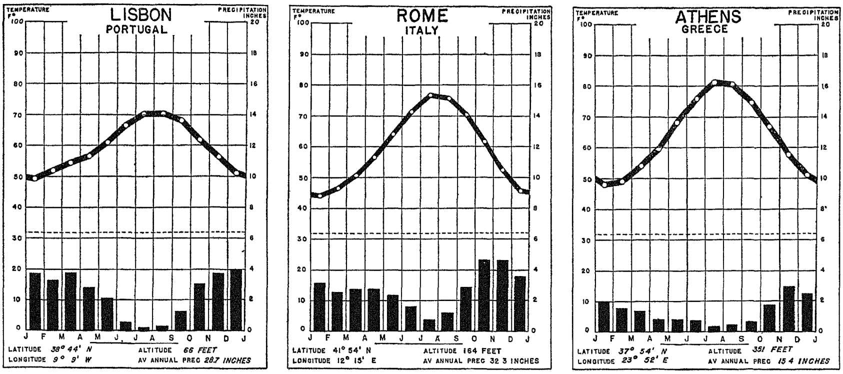


Figure 278 Note the effect of increasing distance from the Atlantic.

snow sometimes appear on the north coast, but their duration is very short. The frost is seldom severe, despite great falls in temperature after sundown, and seldom, if ever, does the temperature remain at the freezing level throughout an entire day. The northern coasts are also liable to cold winds from the north which come from central Europe where the temperature is at the freezing point or below, but the protection afforded by the rim of mountains makes these occasions infrequent.

In the summer months, strong, fresh northwest winds, having the drying quality of trade winds, blow across the Mediterranean. Rain and cyclonic disturbances are rare in the western basin and practically unknown in the eastern basin. The sky is cloudless and brilliantly blue. The clear sky allows the sun to display its full strength. It causes high daytime temperatures, which are especially annoying because of the dust and glare. Average July temperatures reach 75° F. along the coasts and 80° or higher inland. It is so hot that work is often suspended at midday. As there is no rain, rivers dry up and vegetation, except for shrubs and evergreens, withers. The insufficiency of water is the chief drawback of this region in summer. Irrigation must be resorted to for successful summer agriculture.

The Mediterranean type of climate is restricted to the immediate littoral of the sea on whose warmth and moisture it depends. Seldom is the littoral more than twenty or thirty miles in width. While there are endless peculiarities depending upon the nature of the relief and the shelter afforded by the mountains from the colder north winds, this climate is characterized by hot rainless summers, warm rainy autumns, cool rainy winters and springs. Because the rains of the Mediterranean area are essentially of short daily duration, at times much like cloudbursts, bright cloudless skies and abundant sunshine are common the year round.

Economic Development

Mediterranean Agriculture. The agricultural development in this area shows an adaptation to a complex combination of geographic conditions. Owing to the way the Mediterranean Basin is hemmed in by its almost continuous rim of mountains, there is a scarcity of level land adapted to tillage. The coastal plains are narrow and, in addition to these areas, the only other places having suitable soil and climate are the relatively few river valleys.

Soil has suffered because of this topography, and the many generations that have subsisted here have robbed what were once garden spots of their fertility. Where erosion has carried down the top soil into valleys and deltas there are enriched spots, but these are sometimes only temporary, due to the infrequent rains or to floods which shift their locations.

Grains are the leading agricultural crops on the plains. Wheat and barley are the principal crops where the winter rains are the only source of moisture. Corn and rice are grown where irrigation can supply moisture during the dry, warm season—as in the Po Valley. On the hillsides, vines and tree crops

are important. The grassy spaces between the trees are used as pasture for the numerous flocks of sheep and goats. Farther up the hillsides are areas too cool for subtropical crops and these are used either as pasture or for forests.

The tree crops include the citrus fruits, the olive, the fig, and various nut trees. Forest resources are limited and, for the most part, their products suffice only to meet local needs for fuel and building. Some few handmade wood products are exported, but these fall in the class of curios, art objects, or novelties.

Minerals and Manufacturing. Compared with other parts of Europe, the Mediterranean area is poorly equipped for modern manufacturing. It has little coal and, at present, imports English and Russian coal to supply its needs. Petroleum is almost lacking, nor is wood present in large enough quantities to be used as an industrial fuel. Water power is available, but in large amounts only in the northern part of the western basin.

In antiquity, the Mediterranean region was considered rich in minerals. It contains limited deposits of iron, copper, mercury, lead, zinc, phosphate, nitrates, sulphur, and potash. Most of these were present in quantities which sufficed for the modest industrial needs of Greece and Rome, but, with the possible exception of the resources of Spain, the supplies would not last long as a source for modern, large-scale industry.

There are but five important industrial centers in the Mediterranean countries. They are Barcelona, in Spain; Marseilles, in France; and Naples (Napoli), Genoa (Genova), and the upper Po Valley, in Italy. While manufacturing takes place on a small scale throughout this area, it cannot be said to have reached the proportion that would warrant any other centers being termed "industrial." Using relatively primitive methods and local raw-material supplies, household industries are carried on everywhere, but their products are usually for local consumption An exception must be made in the case of rugs from the eastern parts of the Mediterranean which, although produced by primitive methods, do find a market in world trade, more as works of art than as industrial products.

QUESTIONS FOR DISCUSSION

1. Why are the lands around the Mediterranean so densely populated compared with other lands with Mediterranean climate?
2. Which Mediterranean industries are directly or indirectly dependent on the climate? Do these industries produce most of the income of the Mediterranean countries? Explain.

Italy

Italy is now the leading political and industrial power of southern Europe. Her raw-material resources are far inferior to those of Spain, hence her recent industrial growth must be explained in terms of human activity rather than of resources. Both overpopulation, aggravated by foreign restrictions on Italian immigration, and the Fascist movement have contributed to the increased use of the large amount of cheap skilled labor. Today, manufactured products make up nearly half of all Italian exports. The products range from luxurious ocean liners to Florentine leather goods, but textiles and clothing are far more important than other manufactures.

In spite of her industrial rise, Italy is still an agricultural country, and foodstuffs make up an important part of Italian exports. Italy is the world's leading producer of olive oil, and an important producer of lemons, grapes, wine, and early vegetables for markets of Northwestern Europe. Other important food products which enter into the export trade are cheese, macaroni, spaghetti, and canned tomatoes

Northern Italy. Four-fifths of Italian manufacturing is done in northern Italy, which also includes the rich agricultural lands of the broad Po Valley. Equipped with rich soil, rainfall throughout the year, water power, and most of Italy's few industrial raw materials, this progressive section is far superior in resources and development to the rest of the country. It is well served by railroads across the Alps and can readily import, by sea, those two essential minerals —coal and iron—as well as the varied manufactures of Northwestern Europe and the foodstuffs of central Europe. Milan (Milano), Turin (Torino), and Genoa are by far the most important industrial centers, but there are hundreds of other cities and towns which have important industries. Handicraft industries, carried on by the descendants of skilled medieval craftsmen, are common and provide wares for the tourist shops as well as for export. Northern Italy is a place where the Latin culture meets the German, Slavic, and Oriental cultures, hence it is little wonder that such a great amount and variety of skills have accumulated among the working class.

The industrial centers are surrounded by intensively farmed agricultural lands. Unlike southern Italy, the fields and pastures are green in summer. Irrigation or drainage canals divide the rich alluvial plain Long rows of Lombardy poplars line the ditches and break the monotony of the fields of rice, corn, flax, and winter wheat. Evidences of intensive culture

are common: the large numbers of peasants in the fields, the grape vines which are stretched between the fruit trees, and dairy animals which use even the smallest plots of herbage.

North and west of the Po Valley, the snow-covered peaks of the Alps shine in the sunlight. In their valleys are the power plants which provide the principal power for the industrial towns. Some of these valleys have been dammed up by glacial moraines and are occupied by the far-famed Italian lakes which attract tourists from all over the world. The south-facing slopes around these lakes are warmed by the sun and sheltered from the north winds by the high wall of the Alps. Milder in climate than the Lombardy plains below, they yield large harvests of grapes, olives, oranges, and lemons, amazing crops for an area in the same latitude as Montreal. Here, and also in the plains, are large numbers of mulberry trees and a thriving silk industry. Here, and in similar regions in southern France and Yugoslavia, are the only important places outside the Orient where there is sufficient cheap, skilled labor for producing raw silk

Central Italy. South of the Po Valley, the climate (except in the central mountains) becomes decidedly Mediterranean. Summer rain is not entirely lacking, but it is insufficient to keep the grass in the lowlands green or the air free of dust. Grapes, winter wheat, olives, and other typical Mediterranean crops are universal. Irrigation is a necessity if summer crops are to be grown, but the streams from the mountains are not fed from a reservoir of snow as those of the Alps, rather they are likely to be dry when they are needed most. Stagnant waters in slow-flowing streams breed mosquitoes, and malaria is common.

The central core of Italy is the range of the Apennines—moderately high mountains which are rarely barren or precipitous. Hardwood forests and pastures cover their upper slopes, while orchards and vineyards occupy the lower slopes. Like many Mediterranean mountains, they have a fairly dense population, for they are favored places of coolness and moisture in the midst of the dry heat of the Mediterranean summer. Level uplands are intensively farmed; upland pastures are often used in summer for the flocks of the plains.

The most prosperous part of central Italy follows an arc from Pisa and Leghorn (Livorno) up the Arno Valley across the watershed to the upper Tiber and thence down the valley to Rome (Roma). Since early Roman times, this fertile area has been a through route from Rome to the north. This route divides at Florence (Firenze), and the eastern branch crosses the mountains to Bologna on the southern edge of the Po Valley. The Arno Valley was formerly occupied by a series of lakes, which were drained thousands of years ago. Since then, the fertile, lacustrine soil has supported cereals, vines, and fruit trees.

Florence, a city of 316,000, has, since the Renaissance, been the artistic and educational center of Italy. It has developed important manufactures, including woolens, leather goods, and jewelry. Its great wealth made it an important banking center during the Middle Ages. The small but important deposits of copper, iron, and manganese ores, and of Carrara marble, supplemented the agricultural raw materials as a basis for early industrial development.

The Tiber Valley as it descends toward Rome contains the characteristic Mediterranean agriculture Small cities (hill towns) occupy strategic sites along the route and supplement their role as rural centers by handicraft industries (such as pottery making). Rome is located where several valleys come together. It was approximately the head of navigation for the galleys of antiquity, and the seven hills of Rome commanded a place where the Tiber was easily bridged and, thus, controlled an important north-south route.

Rome, today, is a city based largely on the spiritual values of a rich historic past. It has few advantages for manufacturing except its large population (about 1,000,000). The agriculture of the surrounding region is below the standard for most of Italy. But to the world, Rome represents the might and heritage of the Roman Empire and the religious center of the strongest branch of the Christian church. Its ruins and churches attract tourists. Its rank as a political and religious capital gives it a large population of ecclesiastical and political officials.

Southern Italy. Standards of living in Italy decline from north to south. Much of southern Italy is utilized most intensively, but the population is so dense that poverty is general Millions of southern Italians have emigrated and the money they send home to their relatives forms an important part of the income of southern Italy.

Perhaps the most densely populated agricultural area in the world is to be found in the plains around Naples. The active volcano of Vesuvius has deposited rich layers of volcanic ash which produces a superb soil. In spite of the danger of eruption, farmers cultivate even the slopes of this explosive mountain. Groves of chestnuts occupy the middle slopes; below them are vineyards and olive orchards; while hemp, tobacco, wheat, vegetables, oranges, and lemons are grown on the plains. Often three crops—such as

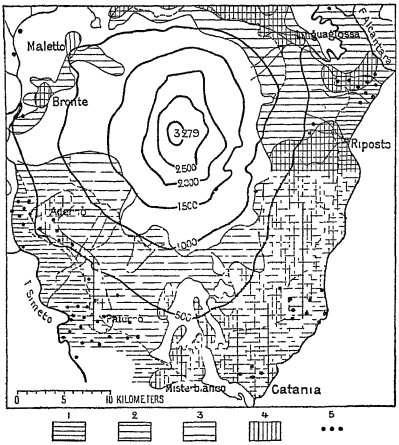


Figure 279. Details of cultivation and settlement around Mount Etna 1. Intensive horticulture, chiefly oranges and lemons, bounded by the upper limit of the olive, 2 Less intensive cultivation, bounded by the upper limit of the vine; 3. More extensive cereal cultivation, bounded by the upper limit of rye; 4. Thickly inhabited areas; 5. Springs. Contours in meters (Courtesy of the *Geographical Review*, January, 1928, published by the American Geographical Society)

grapes, oranges and vegetables—are grown on the same irrigated field.

South of Naples, Italy is mostly rugged and poor. The "heel" (Apulia) is the major exception. It produces more olive oil than any other area of similar size in the world It also produces red wine, wheat, sheep, and goats. The region is so far from the Apennine core that irrigation is difficult. In 1913 an aqueduct, one hundred and thirteen miles long, finally tapped a water supply in the hills of southern Italy.

Sicily. This is a poor, rugged island separated from the mainland by the narrow Strait of Messina. Around Mount Etna is an area of fertile volcanic soil which has developed similarly to the Neapolitan area around Vesuvius. The narrow plain along the north coast has a rich soil devoted to olives, citrus fruits, and grapes. The wide southern slopes of the island are in large estates and, as in Roman days, are devoted largely to raising cereals. Handicapped by much rugged land and by the control of landlords, the Sicilians, who number four hundred to the square mile, must turn to fishing, trade, and emigration to supplement the meager living the island provides.

Outlying Possessions. Sardinia is a backward island of rugged mountains and malarial plains. Its rich zinc, lead, and silver deposits, however, make it highly valuable to mineral-poor Italy.

Italy has attempted to find outlets for its growing population. Until recently its colonies were largely deserts and could, at the most, support a few hundred thousand Italians. Albania is largely under Italian control and may provide employment for several hundred thousand Italians. Ethiopia contains rich lands which may add to the supply of Italian raw materials when effective military control is secured.

Increased manufacturing and commerce, and improvements in agriculture (the drainage of swamps, better seeds and more fertilization) have so far done more for Italy than her colonial expansion.

The French Mediterranean

Marseilles, the commercial capital of Mediterranean France, is near the mouth of the Rhone, but due to the swampy nature of the Rhone Delta, it was built outside the delta region. The hinterland of Marseilles produces important quantities of wine, olives, silk, and silk goods. The chief industry of Marseilles is the processing of raw materials, especially imported vegetable oils, from French colonies.

Directly across the Mediterranean from Marseilles are the French possessions of Algeria, Tunisia, and French Morocco. Their agricultural products are similar to those of southern France, but their season is earlier. Hence, they supply the French market with early fruits and vegetables. They also contain valuable minerals, especially iron and phosphate. As these colonies are directly across from Italy and could supply her with raw materials and room for her expanding population, Italy has long desired to get control of them. At present there are more Italians than French in Tunisia. France, however, is trying to keep her influence paramount by military power and by frequent steamer communication with Marseilles.

France also controls the island of Corsica which in many ways resembles Sardinia, although it is somewhat more mountainous. Sheep and goats are raised in the mountains, with the usual Mediterranean crops on the plains and hillsides along the coast.

The Levant States (Syria, Lebanon, and Latakia), in the area north of Palestine, in the eastern basin, are under a French mandate. They produce cereals for local consumption and a small export of wool, dried fruits, tobacco, and raw silk. The port of Trip-

Figure 280 A part of the Riviera near Marseilles shown on a scale of approximately 1/16,000 This French military map shows relief, roads, houses, forested areas (small circles) and principal crops (Ol olive, V vineyards)

oli is the terminus of an oil pipe line from Iraq, which provides France with her only important oil supply under French control. Beirut, a port to the south of Tripoli, is important in the rug trade. Damascus, located amidst a large oasis, is now the chief political and commercial center.

QUESTIONS FOR DISCUSSION

1. Does Italy possess a well-balanced economy? Explain
2. Why is the northern half of Italy more progressive than the southern half? Why was this not true during the early years of the Roman Empire?
3. Account for the importance of Genoa (Genova) and Venice (Venezia) in medieval trade. Why has Genoa remained important while Venice has declined?

The Iberian Peninsula

Although much better equipped for industry than Italy, the countries of the Iberian Peninsula are predominantly agricultural. Olive oil, oranges, cork, and grapes are characteristic products. Wine is perhaps the best-known product and many well-known types of wine originated here, for example, port from Oporto (Portugal), sherry from Jerez de la Frontera (Spain), and Malaga from the Spanish seaport of the same name.

Spain. This country consists of a ring of lowlands which surround the central Iberian Plateau. Madrid, the capital of Spain, is located in a semiarid, barren area in the center of the plateau. Its main advantage is its central and easily defended position. As in almost every capital, there is some manufacturing, dependent largely on the skill attracted there by the political center. Aside from Madrid, there are few cities, and most of the plateau is devoted to sheep raising (The Merino type of sheep originated here.) The climate is unusually severe because of the altitude and by some is considered similar to that of Russian steppes. Where the rainfall is adequate, the crops are generally wheat, rye, barley, potatoes, and similar hardy crops.

The northwestern corner of Spain is part of Northwestern Europe. Lumber, minerals (iron, zinc, coal, and clay), and animals are the main products of the mountains. Crops similar to those of Normandy occupy the limited plains. The area around Bilbao is

occupied by a progressive people, the Basques, who differ in temperament and language from the Spanish.

The Ebro Basin, between the Pyrenees and the Iberian Plateau, is a semiarid land with some farming and considerable sheep raising. As the climate is somewhat warmer than on the central plateau, irrigation would produce a great variety of crops. The population, however, is sparse and generally backward.

Catalonia, the extreme northeastern part of Spain, is as progressive as the Basque country. Barcelona, the commercial center, is one of the major ports and manufacturing cities of the Mediterranean. Water power from the mountains, local raw materials, and good transportation to the more progressive northern countries account largely for this industrialization. Textiles, cork products, lead ware, glass, electrical goods, and machinery are produced, as well as the well-known Hispano-Suiza automobile.

The coastal plain of eastern Spain south of Catalonia is largely an intensively farmed area raising all sorts of subtropical crops by irrigation. The oranges of this area make Spain the world's greatest orange exporter. In the south even tropical crops, such as sugar cane and date palms, can be grown.

The southern third of Spain is occupied by subtropical Andalusia, which was the principal center of Moorish culture in Spain. Its principal crops are olives, grapes, figs, oranges, and almonds. In the Sierra Morena, which separates the Guadalquivir Valley from the Iberian Plateau, are rich deposits of copper, lead, silver, mercury, and some iron ore and coal. These minerals were the raw-material basis for the metal products for which Spain was known several centuries ago. To the south of the Guadalquivir Valley are highlands which rise to the lofty Sierra Nevada near the coast. On these highlands, temperate crops, and cattle, horses, and sheep are the principal products.

Portugal. Unlike Spain, Portugal faces the Atlantic, although it has a Mediterranean climate and Mediterranean products. It is somewhat more humid and suffers less from high summer temperatures than Spain. Except along the coast, it is poorly developed. Port wine, cork, olives, and oranges are the principal exports. Since the Middle Ages, Portugal has been allied with England, and much of its trade is still with the United Kingdom. Like Spain, Portugal is today a backward country with a mere remnant of its former colonial empire.

Greece

This extremely rugged country, spread over a cluster of peninsulas and many surrounding islands, was once the leader of the world's civilization. Today Greece is a minor state, but in the eastern basin of the Mediterranean Greek influence is still important. Greek ships and Greek merchants are well known throughout the Near East and their activities add considerably to the Greek national income.

Northern Greece (Epirus, Thessaly, Macedonia, and Thrace) is continental, rather than Mediterranean, in climate and agriculture. Its high mountain ridges separate large, fertile plains areas which have always been among the granaries of Greece Wheat, rice, barley, and tobacco are being raised in increasing quantities, especially since Macedonia has been settled by Greek peasants expelled from Turkey in 1923.

Southern Greece is divided into numerous small plains areas which are separated from each other by barren mountain ridges and by water. The winters are mild and rainy—typically Mediterranean—but the summers are much hotter and drier than in Spain and Italy. Agriculture is very primitive and is limited to grapes, currants (named after the ancient city of Corinth), tobacco, and subsistence crops Irrigation is rare, hence the lowlands are almost a desert when the flocks are driven to the highlands during the summer drought. From this ancient center of Greek civilization, Turkish tobacco, currants, and wine are now the only important exports.

The Near East

Egypt. This ancient country was formerly under Turkish control, but is now under British "protection," although theoretically independent. British interests in the Suez Canal route as well as in Egyptian cotton are the principal reasons for British intervention. Italy also has considerable business interests in Egypt and considers it a logical source of cotton for Italian industries and food for the Italian people.

The dependence of Egypt on the Nile was well expressed by Shakespeare in *Antony and Cleopatra:*

> . . . they know,
> By the height, the lowness or the mean, if dearth
> Or foison follow, the higher Nilus swells
> The more it promises; as it ebbs, the seedsman
> Upon the slime and ooze scatters his grain,
> And shortly comes to harvest.

This river which has played such a large part in history and literature is surprisingly narrow. Its

muddy stream irrigates a strip of lowlands from one to nine miles in width through most of Egypt. The fertile area widens at the Nile Delta and forms almost an equilateral triangle with sides one hundred miles in length Except for these limited Nile areas and a few scattered oases, Egypt is desert and almost uninhabited. But the Nile provides both food and drink for Egyptian farmers The rains of equatorial Africa water the Nile throughout the year, while the seasonal rains on the Ethiopian highlands cause the Nile to overflow its banks and deposit a rich layer of mud over the adjacent fields. Thus, the rainless Nile Valley with its annual increment of tropical mud and water supports 14,000,000 people (more than 1000 per square mile of valley land). This rich alluvial land is divided into minute fields (some only a few feet wide) and is used to raise a great variety of crops including cotton, winter wheat, rice, corn, and vegetables Of these, long-staple cotton is commercially most important, for cotton products make up four-fifths of Egyptian exports.

During the period of British control (since 1882), the population has nearly doubled. As a result, fields have been further subdivided and new fields have been watered on the higher lands of the Nile Valley. To permit the use of new lands and to regulate the flow of water, British engineers built a mile-wide masonry dam at the First Cataract (Aswân). An extensive canal system conducts some of this water to new fields and thus realizes new soil resources.

Palestine. The Holy Land is a typical Mediterranean agricultural area of plain, low hills, and a few mountains. In ancient times it was an important trading center because of its location among the important civilizations of Egypt, Babylonia, Persia, and Phoenicia. Now, after centuries of poor usage at the hands of the Turks, it has been turned over to a Zionist state under British protection. The Jewish immigrants, with the financial help of most of the Jewish people, have modernized much of the country and developed considerable irrigation farming. Oranges are now the principal export.

Iraq (Mesopotamia). Like Egypt, Iraq is centered around a great river valley which makes fertile a small portion of the surrounding desert. Like the Nile Valley, the Tigris-Euphrates Valley was the site of ancient civilization and of powerful empires But nomadic invasions and war destroyed the irrigation works on which the culture of this valley was built and the region became but a poor pastoral area with some irrigation farming. Dates, hides, and wool were

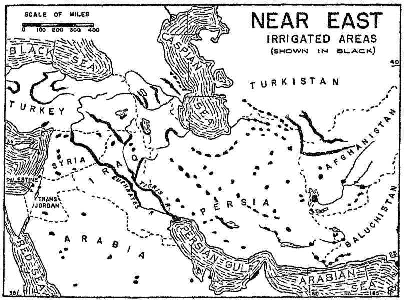


Figure 281. Persia is now officially known as Iran.

the principal exports. Before the World War, the Tigris-Euphrates Valley assumed a new importance as part of the German plan to connect Central Europe with the Orient by the Berlin-to-Bagdad Railroad. Since the war, the valley has become the independent Arab kingdom of Iraq, under British protection. Oil fields have been discovered near Mosul and the ports on the Persian Gulf now export large quantities of Persian and Mesopotamian oil. If the ancient irrigation works were restored, some 7,000,000 acres of irrigable land—which would duplicate Egypt in fertility and products—could be used.

Arabia. This large arid peninsula is typical of the Nomad Lands. Except for the small agricultural plateau in the southwest, which produces coffee and incense, it is of little economic importance, present or potential. Politically, it is of greater significance, for west central Arabia is the Holy Land of Islam. Movements may start there which will spread war of rebellion across the large belt of Moslem lands which almost bisects the Eastern Hemisphere

Aden, a British port on the southwestern tip of Arabia, has an importance disproportionate to the productivity of its barren site. Its position at the mouth of the Red Sea enables its ports to control much of the trade of East Africa, the Red Sea, and the Suez Canal

Turkey. Modern Turkey is but the remnant of the Turkish Empire, which in the seventeenth century controlled all of southeastern Europe, the Near East, and much of northern Africa. It still controls the gateway to the Black Sea and the Anatolian Plateau, a large semiarid upland, almost surrounded by a ring of Mediterranean lands. The plateau is generally barren and suited only to the raising of sheep and goats.

However, there are occasional fertile areas which can, by irrigation or dry farming, be profitably cultivated. But the Turkish peasant is ignorant and conservative; his plow is often a crooked stick, tipped with flint, which barely penetrates the top soil. Except for a few roads and railroads, there is little communication. As in Spain, the fertile areas are scattered and poorly connected. Turkish exports are necessarily few, simple, and easily transported, and include tobacco, Smyrna figs, raisins, olive oil, mohair wool, and Oriental rugs.

Since the World War, Turkey has progressed rapidly. The capital has been moved from Constantinople (Istanbul) to the more centrally located Angora (Ankara). Western manners, science, and legal codes have been introduced, and Turkish cities have been modernized. The new Turkish Government forced Greece to surrender areas around Smyrna (Izmir) which were annexed after the war. Likewise, Italian plans for expansion into Asia Minor have been blocked. Thus, today, Turkey is no longer the "Sick Man of Europe," but a vigorous nation which may soon make full use of its water power, mineral and soil resources and become one of the leading Mediterranean powers.

Iran (Persia). Although subtropical in latitude, Iran is a country of extremes, for most of its better land is 5000 feet above the sea. Its cities are the centers of veritable gardens located where streams from the mountains bring water to the almost barren plateau. Its gardens have contributed much to civilization, for many of our common crops are thought to have been first cultivated in Iran. At present, the oil produced by a British company in southwestern Iran and its fine rugs are its principal contributions to world commerce. It is also important as a buffer state between Soviet Russia and the British interests in southern Asia.

Afghanistan. This wild mountain country, nearly as large as Texas, is of importance in world affairs because throughout history its mountaineers have raided the plains of northern India. Within the present century it has come under British influence and has served as a buffer state to separate India from Russia. The economy of the country, as of most of the Nomad Lands of Eurasia, is extremely self-sufficient. Rugs are the principal Afghan product known in world markets.

QUESTIONS FOR DISCUSSION

1. It has been said that the physical geography of Spain discourages political unity. Why?
2. Why did ancient Greece develop into small city states while ancient Egypt developed as a large kingdom or kingdoms?
3. If the former empires of Egypt, Assyria, Babylonia, Persia, Greece, and Rome could be restored to their ancient power and productivity, would they be serious rivals of the present great powers?
4. Use the Mediterranean Region and the Near East to justify the assertion that "irrigation is the great civilizer"

REVIEW QUESTIONS ON CHAPTERS 44 TO 49

1. Compare Chile and Spain as to physical environment and economic development. Likewise, compare Argentina and Hungary
2. The United States has a "favorable" balance of trade with all European countries except Czechoslovakia and Finland. How might this be explained? Does this fact make it difficult to collect debts owed to the United States by Europe? Should this fact influence our tariff policy?
3. List several typical exports for each European country. Are these based largely on environmental or human resources in each case?
4. What is the major reason or reasons for the economic importance of each of these cities: Buenos Aires, Santos, Pará, London, Liverpool, Manchester, Antwerp, Rotterdam, Hamburg, Danzig, Gdynia, Leningrad, Moscow, Paris, Essen, Vienna, Rome, Istanbul, Odessa, Budapest, Milan, Marseilles, Barcelona, Leipzig, Munich, Warsaw? How accurately can you locate each on an outline map? Is site or position primarily responsible for each city's development?

ANALYSIS OF PLATE XX: THE MEDITERRANEAN REGION

XX A. This scene is at 44° north latitude which is approximately the latitude of Portland, Maine The vegetation is nevertheless subtropical and the temperatures are mild. These conditions are caused by the strong insolation received by the south-facing slopes, by nearness to the warm waters of the Mediterranean, and by the protection from cold winds provided by the mountains. Note how completely man has altered the natural landscape. Each acre of garden represents a considerable investment of human labor at some previous time.

XX B. This photograph was taken from just outside of the walls of Orvieto, one of the Hill Towns of Italy. This city of 20,000 people is located on an isolated rock which provided an ideal site for a medieval stronghold. Note the olive trees in the foreground, and the stack of hay gathered from between the trees. Olives, wheat, and grapes are grown in the valley.

XX C. Primitive equipment and makeshifts are common in northern Africa where the average peasant lacks the capital to purchase any modern equipment.

XX D. Cork is obtained by stripping a variety of oak which grows best in Mediterranean regions The tree is first stripped when it is about fifteen years old and can be stripped every few years for several centuries. Most cork is obtained from highland regions unsuited for more intensive use.

CHAPTER 50

INDIA, SOUTHEASTERN ASIA, AND THE EAST INDIES

THE VAST subcontinent of India, shut off from the rest of Asia by a barrier of high mountains and deserts on the north, has had less human unity than its clear-cut physical separation would suggest. Its people have never thought of themselves as "Indians," but as members of diverse racial, religious, or caste groups. Numerous invasions have created a complex racial and lingual mixture. There are eight distinguishable racial types, nine important religious groups, and two hundred and twenty distinct languages. The caste system further subdivides the Hindus, the predominant religious group, into some three thousand or more castes, each of which has a separate place in the social, religious, and occupational life of the Hindu community. These diverse groups have, for the first time, been welded into at least a partial unity by the British, who by conquest, commercial penetration and law have made of India something approaching a political and economic unit. This idea of Indian unity has now spread to the natives, especially to those who have been educated in European schools, and has culminated in a strong Indian Nationalist movement. This superficial unity, however, should not be allowed to conceal the diversity underneath. Frequent caste and religious disputes trouble both the Indian Nationalists and the British, and thus emphasize the continuing strength of the disunifying forces.

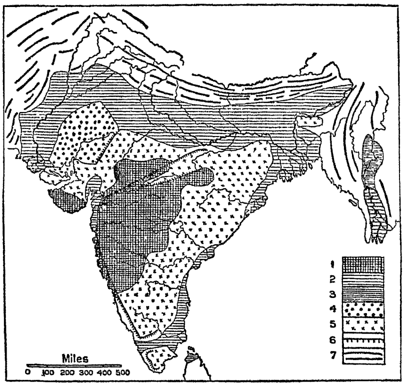


Figure 282. The Structure of India. 1. The basaltic rocks (lavas) of the Deccan; 2. Alluvial plains; 3. The low plateau of central Burma, 4 The Thar Desert; 5 Crystalline rocks of peninsular India; 6 Fault-lines and plateau scarps; 7. Young folded mountains. (From Newbigin, *A New Regional Geography of the World*, Harcourt, Brace)

The Indian Environment

Topography. The triangle is a frequently occurring pattern in the physiography of India The triangular form of peninsular India is obvious. A somewhat rougher triangle can be made of India as a whole. Within peninsular India the Deccan Plateau makes a slightly smaller, homologous triangle Other rough triangles are to be found in the shapes of the alluvial deltas, several irrigated areas, and the area of winter rainfall in southern India.

The three major topographic regions of India are: (1) the northern mountain barrier of high, snow-capped young mountains; (2) the Deccan Plateau of peninsular India—a much dissected plateau of crystalline rock, or, in the northwest, lava flows; (3) the alluvial plain of Hindustan (often called the "Indo-Gangetic Plain") between the first two regions. These topographic regions coincide roughly with the distribution of the major soil groups. Thus deep, rich alluvial soils occur on the Hindustan and other river plains, the black soils, so suitable for cotton, are associated with the region of lava flows and poor to moderate rainfall in northwestern Deccan; and the thin red soils of indifferent quality are found over the crystalline rocks of southern Deccan. As the result of the distribution of soil and moisture, the agricultural population (which makes up nearly three-quarters of the total) follows the relief, and is especially concentrated on the alluvial plains.

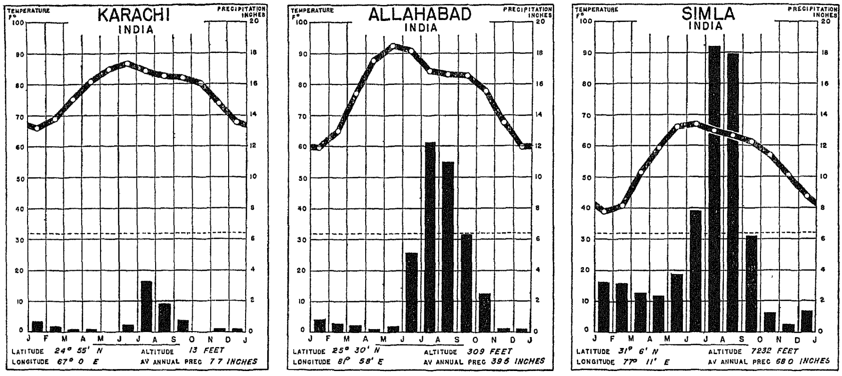


Figure 283. Note the monsoon influence on each chart. Note also the small but important winter rains brought by cyclonic storms from the southern part of the prevailing westerlies.

Climate. The monsoon is the principal control of India's climate. Its importance in Indian business is well stated by the United States Department of Commerce handbook:

> The monsoon is to India what the Nile is to Egypt. . A poor or irregular monsoon may not only cause acute suffering in many districts but also make for bad business conditions throughout the country and a falling off in imports. A good monsoon, on the other hand, brings vitality and strength into every branch of business and increases imports. The monsoon has such an important effect on general trade that the season in which it occurs will afford data for deciding on a business policy for the year, either of curtailment or expansion. There is a reluctance to enter into business engagements until it is known whether the monsoon is a success or failure. For this reason, commercial travelers find the most advantageous time for entering India is toward the end of the monsoon, or in September or October. They can then have the advantage not only of cooler and healthier conditions for personal work but also can find their customers in a more definite frame of mind as regards purchase of goods.[1]

Except for a small but important amount of winter rainfall in northwestern and southeastern India, almost all of the rain depends on the monsoon winds. The Meteorological Department of the Indian Government divides the year into four seasons as follows:

Seasons of the northeast monsoon:

1. January and February—the cold-weather season.
2. March to mid-June—the hot-weather season (very dry)

Seasons of the southwest monsoon:

3. Mid-June to mid-September—season of general rains
4. Mid-September to December—season of retreating monsoon, with decreasing rains except in the south east where the maximum rainfall is in November and December

[1] *Commercial Travelers' Guide to the Far East*, pp 237-238, United States Department of Commerce, Washington, 1926

The average annual temperatures decrease from south to north, but elevation often offsets the effect of latitude. Considering the subtropical and tropical latitudes, there is considerable seasonal change, especially in the north. Average temperatures in January exceed 75° in the southern two-thirds of the peninsula, but drop to an average of 60° to 70° in the northern plains, and much lower in the mountains. The protection of the Himalayas generally shields the northern plains from freezing temperatures.

The highest temperatures usually occur at the end of the dry season—May and early June. The coming of the monsoon rains moderates the actual temperatures, but the increased humidity makes for high sensible temperatures. During the hot months, European residents who can possibly do so move to the hill stations. The political capital is moved from Delhi in the northern plains to Simla, about two hundred miles to the north with an altitude of 7200 feet and an average temperature during the hottest month (June) of 67.8° F. During the hot season the sea-level temperatures tend to increase to the north, especially away from the ocean. Thus Cochin, a port in southern India, has an average temperature for June of 80°, while Allahabad, at an altitude of 300 feet in the Ganges Valley, has an average of 92.6° for the same month.

The Indian Economy

Agriculture. The total area of India is 1,164,000,000 acres, of which 57 per cent is in British India and the remainder in the native states. It has been estimated that 42 per cent of the area of British India is capable of cultivation, 13 per cent is forest land, and the remainder is either waste land or not available for cultivation because of other uses. Although 42 per cent is listed as available for cultivation, only 34 per cent (225,000,000 acres) has been used for crops in recent years If allowance is made for multiple cropping the area actually used amounts to 265,000,000 acres or about one acre per capita. Compared with the per capita acreage of other countries, this is extremely low, and indicates more clearly than anything else the poverty of the great mass of India's population Food crops represent approximately 80 per cent of the total acreage and commercial crops occupy the other 20 per cent. Of the food crops, rice, millet, and wheat are most important, occupying approximately 30 per cent, 14 per cent, and 9 per cent, respectively, of the acreage sown. The other important food crops are sugar, spices, fruits, and vegetables. The fiber crops, such as cotton, jute, and hemp, represent about 10 per cent of the sown acreage. Other crops are oil seeds, tobacco, dyes, tanning materials, tea, coffee, opium, and fodder crops.

In spite of the great density of the agricultural population (exceeding two thousand per square mile in the eastern Ganges Valley), the standard of agriculture is low Poor seed, poor methods, low-quality crops, and inefficient division of the fields are characteristic. This is not surprising, since two-thirds of the people are illiterate, and the heavy hand of tradition and the caste system discourages progress. Good steel agricultural implements are generally unknown, and the average Hindu peasant could not afford them even if he realized their advantages. It is not easy to save money for better seed, efficient machinery, and chemical fertilizers when the family income ranges from twenty-five dollars to one hundred dollars a year.

In many sections of India, due to the prevailing system of land holding and inheritance, large tracts have been split up into innumerable small, scattered farms. The problem of combining these small farms is one of the most important facing the British Government in India today So small are some of these tracts that they cannot furnish a family sufficient sustenance, and some of the family must engage in "cottage industries," or hire out as laborers on the larger farms. The further effect of the division into minute fields is to make impossible the use of new farming methods and machinery It is natural, therefore, that the greater part of India's agriculture is still carried on with antiquated tools and by primitive methods.

Unusual expenses, such as seed and food purchases after a drought or the cost of elaborate but necessary marriage and funeral ceremonies, have forced many peasants into debt. Many are held in virtual slavery by the moneylenders Fully 95 per cent of the agricultural capital of the country is estimated to have been advanced by village moneylenders, who charge 10 per cent, 25 per cent, or even 60 per cent interest, according to the risk involved.

Animals are common but are of little importance either for meat or manure. Milk, hides, skins, wool, and labor are the main products of some 220,000,000 animals in British India. Even for these products the animals are not efficient producers, for the breeds are poor, fodder is scarce and poorly balanced, and animal diseases are rampant

Manure, so intensively used in China and Japan, is rarely applied to the fields of India. Usually the cow dung is plastered on a wall to dry, and is later used as fuel. This practice and the lack of crop rotation, as well as the export of nitrogenous crops (such as oil seeds), have led to soil exhaustion. Unusually fertile soil and very intensive cultivation in some areas occasionally result in fair yields, but heavy fertilization will be necessary to overcome centuries of maltreatment and make it possible to attain the average yields of European agriculture.

Meat is taboo to those of the Hindu and Buddhist faiths, and pork is taboo to the Moslem and Jewish population. Members of other sects often refrain from meat eating to avoid offense to their neighbors. Thus, in this land of frequent famine, a large food resource is consistently neglected.

Cattle of the zebu variety, the sacred animals of the Hindus, make up two-thirds of the animal population. They pull the primitive plows and oxcarts as well as provide the milk and butter which are important parts of the Hindu diet. In the moister regions they are replaced by the buffalo, which is stronger and produces a richer milk. Sheep and goats are important in the hilly and drier areas as in northwestern India and the Deccan Plateau. Camels are used in the Thar Desert and in the extreme northwest.

In normal years, the population of India has barely enough food to survive, and yet the population continues to grow. What, then, are the possibilities for agricultural expansion? The British agricultual ad

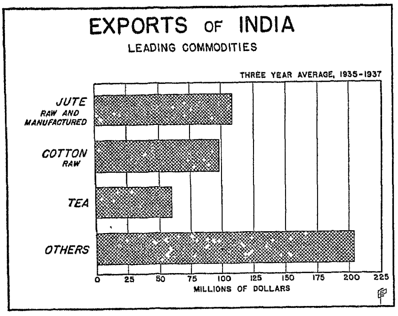


Figure 284 A few staples make up the bulk of the exports of India

visers have made some progress by introducing better varieties of seed, better crop rotations, and breeding better animals. Such methods make but slow progress among the masses, for personal visits to demonstration farms are usually required to convince the conservative peasants. More effective has been the additional land brought under cultivation by irrigation. This has reduced the uncertainty of the water supply in many drought-stricken areas as well as added productivity to desert lands. It has been stated that "India adds an Egypt to her area every year and the world takes no notice." [1]

Forest Resources. The proper care of the forest resources of India would furnish grazing areas for cattle, supply fodder, add to the human food supply directly, replace cattle manure that is now used for fuel, and permit of increased crop yields, as well as larger revenues from the timber supply. Although nearly 30 per cent of the area of India is forest or woodland, these resources are unequally distributed. For example, 68 per cent of the land of Burma is forested but only 5 per cent of the United Provinces, a densely populated part of the Ganges Valley. The teak of Burma and the tropical hardwoods of the mountainous country of southern India and the Himalayan softwoods are important commercial timbers, but they do not contribute to the needs of the average peasant for fuel and building materials.

Mineral Resources. India has long been known for its gold, silver, and precious stones, but it is the great accumulation of these in the hands of its rulers rather than their production which has given India its reputation. More important are certain mineral resources found on the edge of the Deccan Plateau, especially on the northeastern border. Coal, manganese, and iron ore are the most important and have formed the basis for a small iron industry as well as an export of coal and manganese.

Industry. Slightly more than 10 per cent of the people of India are engaged in manufacturing. While this is unimportant on a percentage basis, numerically it indicates that 35,000,000 people are engaged in these occupations. The important industries in India are those concerned with the manufacture of textiles, the polishing of rice, the packing of tea, and a complex lot of "community industries," such as sugar and petroleum refining, printing, and the manufacture and repair of railway equipment. Textiles are by far the most important, employing in the cotton branch approximately 23 per cent of the industrial workers, in the jute mills 20 per cent, and for the whole textile group, more than 60 per cent.

Most of the modern factories are located in the leading cities of Calcutta, Bombay, Madras, and Karachi, or their immediate hinterlands. Many of the manufacturing industries of India are, however, small-scale "cottage industries," and are therefore distributed in much the same way as the population.

The great majority of the factory workers are migratory and employed on a part-time basis. They engage in industry when crops fail, or after the harvest season is over There is, therefore, no large industrial working class, and mechanical ability is almost lacking. These characteristics of the workers tend to make for higher costs of operation, which often overbalance the low wages paid.

Commerce. Until the British occupation, India lacked any coordinated system of transportation. Occasional caravans carried the small internal traffic and traded overland across the northern and northwestern borders, while the produce of the immediate hinterlands of a few ports entered into the small waterborne foreign commerce.

At present, numerous lines of modern freight and passenger vessels stop regularly at Bombay, Karachi, Madras, and Calcutta, and occasionally at the smaller ports. Forty thousand miles of rail routes connect the larger cities with the principal seaports. Modern highways and truck services act as feeders to the railways. Although these transportation facilities by no means serve every village, or even small city, in India, nevertheless the framework has been built for a complete system of communication. No longer do millions die

[1] L. Dudley Stamp, *Asia, an Economic and Regional Geography*, p. 198. E. P. Dutton, New York, 1931.

of starvation because transportation to the famine belts from the ports and areas with a food surplus was not available.

Most of the foreign trade of India is carried by ships; the overland trade is negligible. The chief exports are jute and jute manufactures, raw cotton, tea, cotton manufactures, wheat, oil seeds, hides, and skins. The principal customer is the United Kingdom, but Japan, the next best customer, is rapidly increasing its purchases of raw materials.

The imports of India are manufactured goods and sugar. Ordinarily they total much less than the exports This highly "favorable" balance of trade is probably offset by three items: (1) dividends paid to English investors, (2) salaries and pensions paid to Englishmen in the Indian Army, Civil Service, or trade; (3) imports of gold, silver, and precious stones.

The last item is of considerable interest, for India has imported the precious metals since the beginning of history. Often these imports represent the savings of Indians working abroad, or the imports of jewelry for the Indian princes. Many poor Indian peasants own surprising quantities of gold and silver ornaments. This highly negotiable property is a reserve against famine and can be concealed more readily from the thieves or looting armies than other property. The bracelets and nose rings of the Hindu women often serve both as savings accounts and insurance policies.

QUESTIONS FOR DISCUSSION

1. Compare India and European U S S R. as to economic development, products, and problems.
2. Why do June temperatures increase from south to north in India?
3. Examine a population map of India. (A large wall map or a detailed map in a large atlas is best) What relations seem to exist between rainfall, relief, and population?

Regional Geography of India

The Himalayan Barrier. The barrier effect of the highest mountain range in the world is added to by the height of its passes (more than 14,000 feet) and by the highest plateau in the world which adjoins it. Elsewhere in India, British control is certain, but the people of the mountain barriers accept British advice rather than bow to British power. A barrier of unhealthful tropical forest covers the Himalayan foothills and separates the peoples and industries of the mountain from those of the plains. The mountain peoples are Mongolian in race, and nomadic or seminomadic in occupations. Nomadic agriculture is the rule except in a few fertile basins, and flocks and herds are common in the alpine pastures. European penetration has been slight except in a few favored spots—notably Kashmir, the hill stations of Simla and Darjeeling, and the tea gardens of Sikkim.

The Arid Northwest and Its Oases. Northwestern India is an arid land, bordered on the west by the dry and wild mountains of Afghanistan and Baluchistan. This is the land gateway of India through which passed Alexander the Great and numerous other conquerors. It is a nomadic frontier land where the wild life of the pastoral nomads contrasts sharply with the sedentary life of the more numerous but less military oases dwellers.

The oases are generally small in Afghanistan and Baluchistan. No wonder, then, that the gigantic oases of the Indus impressed the newly arrived conquerors with the wealth of India. The widest part of the Indus Valley, the Punjab ("land of five rivers"), makes a great inverted, irrigated triangle, 200 miles wide at its base along the foothills of the Himalayas and extending more than 300 miles to its apex at the junction of the Sutlej and the Indus. The northern part of this area receives extensive winter rainfall from cyclonic storms which cross the mountains from the Mediterranean Sea. This rain suffices for a winter wheat crop, but irrigation is used to supplement the monsoon rains in summer.

The southern Punjab and the lower Indus Valley (the Sind) would be a desert instead of an important wheat and cotton area if it were not for the nourishing waters of the Indus and its tributaries. Each year this region sends out exports of wheat, cotton, barley, and oil seeds through Karachi, the port of the Indus Delta. Drought is less menacing here, for irrigation completely supplants rainfall. Only when the rains in the Himalayas are insufficient to produce heavy flood waters do the peasants on the marginal fields suffer. Even this risk is being reduced by damming up the water and gradually releasing it through canals. This method is more certain than the inundation canals which depended on the force of the flood waters to irrigate the fields. Damming the water has the further advantage of permitting perennial irrigation rather than seasonal flood irrigation whose timing depends on the rains and melting snows in the mountains.

The Ganges Plain. This huge, densely populated plain, which is 1000 miles long and from 100 to 250 miles wide, is the heart of agricultural and religious India. The Ganges, the sacred river of India, occupies a wide trough which it floods during the summer These same flood lands produce a high yield in win-

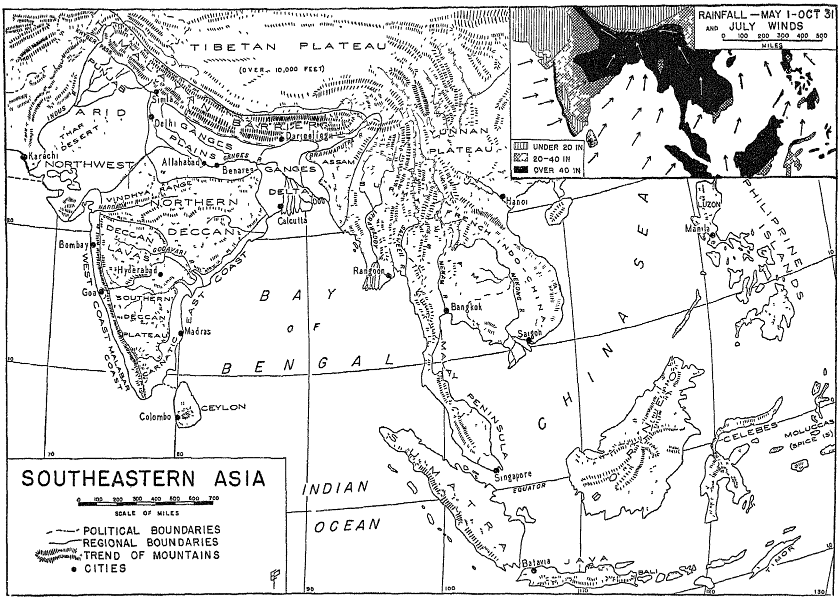


Figure 285 Siam is now officially known as "Thailand"

ter crops. To the north of the Ganges a wide, flat alluvial plain extends to the abrupt southern edge of the Himalayas To the south the land rises gradually to low hills which border the Deccan Plateau. Rainfall decreases westward from the mouth of the Ganges, and has a marked influence on the distribution of crops. Rice is most common in the Delta and lower valley where the rainfall ranges from eighty to forty inches per year, but gives way to wheat, barley, and millet northwest of Lucknow and Cawnpore where the rainfall is less than forty inches. Sugar cane is almost universal. Irrigation is becoming increasingly important in the drier lands of the west, while drainage is necessary in the rainier east.

The dense population is concentrated in countless small agricultural villages, largely because in more troubled times community life was necessary for defense. Numerous large cities are also found along the Ganges. Many of these are former political capitals or have grown up around religious shrines. The numerous visitors to these religious and political centers attracted tradesmen and artisans. Thus the Ganges cities became centers for Indian handicrafts. Several of these cities have developed modern factories to take advantage of the local labor supply—as, for example, the cotton mills at Delhi

The Ganges-Brahmaputra Delta. At the junction of two of the great rivers of Asia is a hot, humid delta, crisscrossed with rivers, creeks, and canals. This low-lying land suffers from floods, and its peoples must live on mounds above their fields. Even in a normal rainy season, it is impossible to go from one village to the next without using a boat. These same flood waters have deposited, and continue to deposit, a wealth of rich silt, which yields sufficient harvests of rice, jute, and oil seeds to support one of the most concentrated populations in the world.

Calcutta, a city of more than 1,100,000, is the seaport, not only of the Delta, but of most of the Ganges and Brahmaputra valleys. It is seventy miles from the coast on a distributary of the Ganges and is connected with most of the Delta area by a network of streams and canals. Over these is shipped the jute which is the principal raw material for the Calcutta mills.

Assam. The rain-drenched hills and adjacent valleys of Assam might well be called "the tea garden of India." The absence of any completely dry season insures the almost continual growth of the tea leaves, while the hillsides and gentle valley slope provide the drainage which the tea bushes require. Cheap labor is imported from the dense agricultural population of the adjacent Ganges Delta and plains.

Peninsular India. Peninsular India will hereafter be considered in five parts, each of which has distinctive characteristics. The central plateau is bordered by a narrow, rainy coastal lowland on the west, and slopes from the Western Ghats gradually toward the east to a broad, rolling eastern lowland which has been extended eastward by several river deltas. The triangle of the plateau itself is bordered by mountains. Its southern tip consists of the Cardamom and Nilgiri hills which rise to more than 7000 feet. The almost continuous crest of the Western Ghats (usually more than 3000 feet in elevation) terminates the plateau to the west, as do the less continuous Eastern Ghats on the east. The Vindhya Range and other discontinuous low mountains form an irregular northern border. Within this mountain rim are three subdivisions the old crystalline rock mass of southern Deccan, the lava region in the northwest where volcanic lavas have been deposited in thick layers over the crystalline rock; and the much dissected, crystalline area to the north which has lost most of its plateau characteristics.

The West Coast. This narrow coastal strip receives the full force of the southwest monsoon and, consequently, has a heavy rainfall. The soil is generally rich because it has developed on alluvial fans deposited by the short streams flowing down the west slopes of the Western Ghats. North of 15° N. the people live largely by self-sufficient agriculture, with rice farming on the alluvial fans and coconut groves on the sandy coastal areas. Bombay is the only large city. Its importance is due to its hinterland on the Deccan Plateau (with which it is connected by a pass through the Ghats) rather than any trade it may have with the coastal strip.

The southern third of the West Coast is the famed "Malabar Coast," the destination of the earliest European trading ships. Here, a dense population, rich alluvial soils, and a long rainy season permit the growth of a wide variety of spices—especially pepper, cinnamon, nutmeg, and ginger. Coconuts and rubber are other important commercial products. Rice and a great variety of fruits and vegetables provide a more varied diet for the natives than is found in most of India, and fishing along the coast and in the lagoons provides further variety. Teak and other hardwoods are important products of the adjacent mountains.

The Deccan Lavas. The rainfall (twenty to forty inches) is as sparse here as in the Southern Deccan but the greater moisture-retaining power of the soil makes it more effective. Irrigation canals and tanks are rarely used, yet two-thirds of the land is under intensive cultivation. Wheat and flax are the common winter crops, with cotton and millet succeeding them in the summer. The high fertility of the black soil, combined with the great amount of level land formed on the volcanic terraces, makes this the great cotton region of India. Here is the source of raw materials for the great Bombay textile mills. Unlike so many parts of India, this region produces primarily for sale rather than for local consumption.

Southern Deccan. Compared with the surrounding regions, the southern Deccan Plateau is sparsely populated (twenty-five to two hundred people per square mile). Not only is it in the rain shadow of the Western Ghats, but the red soils formed from the old crystalline rocks are generally poor. Much of the land is grass covered and suited only to cattle and sheep, both of which play a more important part in the native economy than elsewhere in India. Millet and cotton are the principal nonirrigated crops. Along the streams and around the tanks are intensively cultivated areas with rice, pulses (beans and peas), and spices as major crops.

Northern Deccan. This region (which could with equal logic be divided into half a dozen or more smaller regions) includes almost all of the diverse aspects of Indian life. In its most rugged sections are primitive peoples who, until recently, hunted with bow and arrow and lived mostly on the game and fruits of the forest. Certain lowland valleys are moist enough for an agriculture resembling that of the Ganges Delta; other valleys specialize in cotton and dry-land crops. Racially, the region is equally diverse, for here the Aryans from the northwest, the Mongolians from the northeast, and the Dravidians of the south mixed with the primitive stocks which occupied India before the dawn of history.

The East Coast. The southern part of this coast, called the "Carnatic," nearly equals the Ganges Plains in population density. Much of the area is an intensively cultivated coastal plain growing rice, millet, sugar cane, tobacco, and vegetables. The rainy season is brought by the northeast monsoon which picks up moisture in crossing the Bay of Bengal. The summer is almost dry, for the Carnatic is then in the rain

shadow of the mountains and plateaus of peninsular India. The average rainfall is but barely adequate for such an intensively cultivated region and is commonly supplemented by irrigation from countless wells and "tanks" (ponds). In dry years the tanks and wells may dry up, and serious famines have resulted.

Madras, the third largest city of India, is located at the northern end of the Carnatic region. It is the principal seaport for southern India, but its harbor is almost entirely artificial. Its location is due to a grant of land given to French traders by native rulers rather than to any great natural advantages. Aside from a few cotton mills, its industries are connected with the processing of materials handled through the port.

North of Madras, the coastal lowland is narrower, and, on the whole, the region is less developed except where river deltas offer areas of rich soil. Rice and spices are the principal crops on these populous, irrigated deltas, but millet and other dry crops are important elsewhere.

QUESTIONS FOR DISCUSSION

1. Which regions of India seem to have the greatest possibilities for increased production?
2. How does peninsular India differ from the plains of Hindustan? Are there any similarities?
3. Where are the great famine areas of India? Why? What measures may be taken to prevent a famine?

Ceylon

This island is slightly more than half the size of Pennsylvania. It resembles southern India in its environment and economy, but there is considerably more emphasis on plantation agriculture than on small native farms. This is reflected in the foreign trade. Half of the exports consist of tea, and the other half is almost equally divided between rubber and coconut products. The imports include not only manufactured products, but also food for the plantation laborers.

The island can be conveniently divided into three regions. The mountainous core and its humid interior valleys produce tea, rubber, graphite, and gems. The coastal plains, especially to the south and west, produce rice, mangoes, breadfruit, spices, and coconuts. The remaining area, the northern limestone plain, suffers from drought and poor soil. Its scrub forests and palm trees are of almost no present or potential use.

Colombo, the capital and principal seaport, has a fine artificial harbor. It handles not only the trade of Ceylon, but also considerable entrepôt trade for Indian ports.

Indo-China and the East Indies

With a few exceptions—such as Java—this large area is less densely populated than other parts of monsoon Asia. During the Christian Era, it was first a colonial area for the peoples of India and China, and, in recent centuries, for European nations. The racial as well as political history of the area is complex. Assuming (as is the generally accepted theory) that man originated in Asia, then the aboriginal Australians, the Polynesians, and the dark-skinned Melanesians probably passed over this land bridge from Asia to their peripheral homes. A group of Negritos (pygmies) also penetrated the area, and today form the most backward element in widely scattered districts. No doubt they were pushed into isolated districts by the Malayan peoples, an offshoot of the Mongolian race. Nearly two thousand years ago the Malays were strongly influenced by an influx of settlers from India These established kingdoms at several places in the East Indies and Indo-China and, during a thousand-year period, introduced Hinduism and other aspects of Indian culture. The Hindu ceremonies at Bali and numerous temples are remnants of this period. About 1000 A.D., Mongolian influences again became dominant, and such Mongolian peoples as the Siamese and Annamese, as well as numerous Chinese traders, entered the area The Chinese still make up an important part of the merchant and coolie class. The Chinese influence was perhaps lessened by the influx of Arab traders, who converted the Sumatran Malays to Mohammedanism in the thirteenth century. Inspired by their new and aggressive faith, these Malays conquered most of the East Indies, including parts of the Philippines. Their expansion was stopped by the arrival of the Portuguese, Spanish, and Dutch, and later, of the English, French, and Americans.

Geology. It will be found helpful in understanding this area to know at least the outlines of its geology. The basic structure is a mountain block which continues southward from the Yunnan Plateau of China. Parts of this block have been depressed to form basins, which have since been covered with a thick layer of alluvium. Other areas have received lava intrusions which have deposited minerals, such as tin. A few areas of the old block are still mountainous, such as the Annamite cordillera which forms the backbone

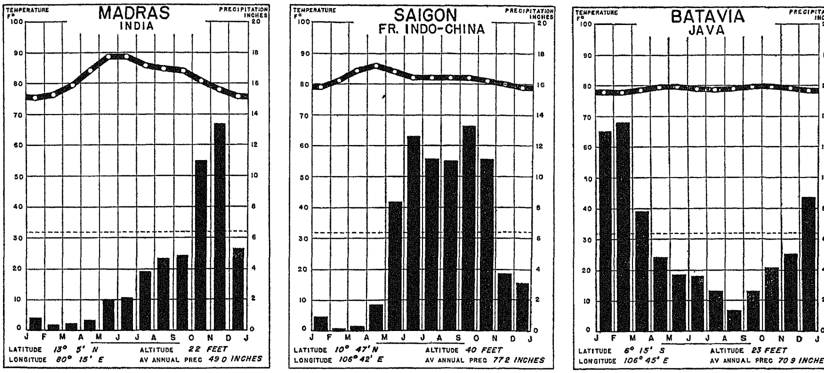


Figure 286 How might the differences in the time of the rainy seasons be explained?

of French Indo-China and the chain of hills and low mountains which forms the Malay Peninsula.

Against this block, and especially on its southwestern edge, have been folded a great chain of young mountains which form the backbone of Sumatra and Java, and send spurs on to the other islands such as the Philippines and New Guinea. This folded area is still a fault line of considerable weakness. Earthquakes are not uncommon, volcanoes and lava flows are widespread. It is not especially difficult to trace many of these geological features on a good physical map which shows the depths of the sea.

The Peninsula of Indo-China. This great peninsula is ruled by three countries, the United Kingdom, France, and Thailand (Siam), but since each geographic region is represented under each rule, it is more convenient to treat the area as a unit. The three geographic regions are: (1) the forested mountainous areas; (2) the drier inland plains or plateaus; and (3) the densely populated alluvial plains. Of these, the last forms the economic heart of each political unit, and contributes the principal exports.

The mountain chains are high as they branch out from the Tibetan and Yunnan plateaus, but they become less rugged to the south. Usually they are covered with thick, hardwood forests, including the valuable teakwood which is cut in the more accessible areas, especially near the main rivers. Minerals are found in great variety: silver, lead, tin, rubies, and tungsten in Burma; tin, gold, and coal in British Malaya; gold, iron, zinc, manganese, and coal in Thailand, and coal, zinc, tin, and phosphates in French Indo-China. The exploitation of these is quite uneven and incomplete. They are almost neglected by the mountaineers who live by hunting, nomadic agriculture, and by terracing the lower slopes into rice fields.

The dry inland basins differ somewhat in their resources and exploitation in each unit. In Burma, the dry belt is moderately populated by farmers engaged in raising millet and other dry-land crops. The basin is underlain by important petroleum fields which provide an oil supply for British fueling stations in the Orient. In Thailand the drier area is a low plateau, whose poor soil and long dry season restrict the natural vegetation to scrub forest and the sparse population to a precarious farming combined with stock raising. The Cambodian part of French Indo-China is but slightly better than the neighboring Siamese region. Most of its populace lives along the Mekong River, and utilizes its fish and irrigation waters. Cattle and pigs are raised in large numbers—the former for export, the latter for home consumption.

Most of the population is found on the moist alluvial plains. These are almost completely occupied by rice fields and intersected by a network of irrigation canals. Even the villages are built around canals, and each is a miniature Venice. The chief product is rice which, with the fish caught in the canals and streams, forms the ordinary diet. Rice is likewise the chief export—in fact, the bulk of the world's rice exports originate on these plains. Compared with the crowded millions of India and China, these rice farmers have

a high standard of living with little fear of famine. The population is only moderately dense and the growing season lasts all year, hence a considerable food export is possible.

In French Indo-China—and more especially in the Malay Peninsula—huge plantations have been established to grow tropical products. Rubber is by far the most important and overshadows the other products The rubber plantations are located not only on the plains, but also on the gentle lower slopes of the hills. Other plantations—often developed by the Chinese—produce pepper, pineapples, tobacco, coconuts, and cassava.

Singapore, on a small island at the tip of the Malay Peninsula, is the leading port of the region as well as one of the great entrepôts of the world. Its entrepôt nature is clearly shown by the duplication of many of its imports in its exports. By far the most important are tin and rubber, for which Singapore is the major world market.

The Philippine Islands. This newly created republic lies in the trade-wind belt rather than in the doldrums. The western slopes of the islands (which would normally be dry in the northeast-trade-wind belt) receive heavy summer rains from the winds of the Asiatic monsoon. Thus the islands are rainy throughout, with an average fall of more than sixty inches. Typhoons (especially in the north) are the main climatic handicap

Structurally, the islands are built around a framework of folded and volcanic mountains which are connected with the folds of Java and Sumatra. Rice is grown on the steep terraced slopes, especially in the north. Elsewhere the mountains are thickly forested, and cabinet woods, bamboo, dyewoods, and gums are the principal products. The plains which occur between the mountain ridges contain most of the agriculture and, therefore, the bulk of the population. The most important region is the central plain of Luzon which extends northward from Manila. Here, rice is raised for food, and sugar and tobacco are raised for export. The sandy coastal strips of the islands are important for their coconut plantations. Another major product is abaca (Manila hemp) which is grown along the east and southeast coasts, south of the typhoon area.

The exports of the islands consist largely of sugar, coconuts, Manila hemp, and an increasing amount of rubber. The imports include manufactured goods, coal, petroleum, and foodstuffs. This last import is surprising, since there is much good agricultural land available, and the Filipinos could raise their own foodstuffs. In fact, in resources and density of population, the islands resemble Indo-China and, like that area, could become an important rice exporter.

Netherlands India. The Dutch colonial empire is considered to be a model of colonial administration. In few other tropical lands have European governments succeeded so well in increasing production, making a profit, and, at the same time, increasing the number and contentment of the natives.

The Dutch possessions lie almost astride the equator and have an equatorial type of climate. Although there are some slight seasonal changes, usually the seasons are best described as "very rainy" and "drier" rather than "wet" and "dry." The climate is hot, but never so extremely hot as in India. By using suitable clothing and houses, the Dutch colonists find it possible to live a normal life in most of the colonies. The mountainous nature of the islands makes a cool hill station available to every lowland city. The Dutch settlers form a permanent community, whereas most Englishmen in India and Malaya expect to retire to England.

Java and Madura. Java and its small neighbor represent the well-developed part of the Dutch possessions. The remaining islands—nearly fourteen times as large in area and, perhaps, of almost equal quality in soil and mineral resources—have only 14,600,000 people compared with 37,000,000 for Java and Madura. The Dutch consider these less-developed islands as a reserve for the future At present, the greatest progress is being made on Sumatra, Java's large neighbor to the northwest.

Although only 36 per cent of Java is lowland, more than 40 per cent of the land is cultivated. Japan, with but slightly less lowland, has only 20 per cent of its area under cultivation. This comparison reflects the industry of the Javanese as well as the richness of Java's volcanic soil. Careful terracing and other soil methods prevent this available material from being rapidly leached and washed away.

Three major types of topography are present, and the land use is closely adjusted to them. Along the coast there is an alluvial plain which is especially wide and fertile on the north. Just inside this plain on the south is a high mountain belt, consisting of very young volcanic cones and somewhat more mature folded limestone mountains. These are the source of the rich alluvial material in the plains below. Between the mountains and the northern plain is a hill area with mediocre soil. It is of considerable significance because it contains a large oil field.

The basic crop of the island is rice, and by various

restrictions on the cultivation of other crops the Dutch Government makes sure that adequate food is produced before commercial crops are raised for export. Contrary to a common impression, native agriculture is far more important than plantation agriculture, although the latter produces the bulk of the exports (Fig. 287).

Figure 287

LAND UNDER CULTIVATION IN JAVA

Native cultivation	Irrigated rice	7,272,000 acres
	Upland rice	1,100,000 acres
	Corn	4,837,000 acres
	Cassava	1,676,000 acres
	Sweet potatoes and yams	419,000 acres
	Peanuts	483,000 acres
	Soybeans	421,000 acres
	Other crops	2,292,000 acres
	Total native	18,500,000 acres
Estate cultivation	Sugar	457,000 acres
	Rubber	481,000 acres
	Tea	211,000 acres
	Coffee	200,000 acres
	Other crops	751,000 acres
	Total estate	2,100,000 acres

Below 2000 feet there is a hot, wet forest zone. Sugar and rice are the principal crops on the plains, while rubber, teak, pepper, bamboo, and acacia plantations occupy the hillier areas. Above 2000 feet corn is added to rice and the plantation crops include tea and coffee, cinchona (quinine) and coca (cocaine) are added above 4000 feet. The highest areas are largely devoted to forest or alpine pasture with small areas of such temperate European crops as rye and potatoes.

Sumatra. In climate and crops, Sumatra is similar to Java, which it greatly exceeds in size but not in production. Its topography is somewhat simpler—consisting as it does of a high mountain backbone near the southwest coast, a wide plain to the northeast, and a narrow but better-developed plain to the southwest. Large plantations of rubber, palm oil, tobacco, coffee, and other crops produce most of the exports. Land for these is more readily available than in Java, since the native population is much less numerous However, the non-European population is increasing, due to the immigration of Javanese, Chinese, and even a few Hindus to work on the plantations.

Borneo. This huge island (larger than the British Isles) is almost undeveloped except for scattered areas along the coast The northwestern plains are British colonies or protectorates They have been developed much more intensively than Dutch Borneo, possibly due to the lack of similar territory elsewhere in the British Oriental possessions. Petroleum fields are of considerable importance Otherwise the products are similar to those of the lower lands of Java.

Other Islands. Little need be said of the other islands, except that they are probably undeveloped duplicates of Java and Sumatra. Many of the islands, especially the huge island of New Guinea, are incompletely explored and, except for a few coconut and spice plantations near the coast, are entirely in the hands of a sparse, native population.

QUESTIONS FOR DISCUSSION

1. How might you account for the development of British Malaya and Java before that of other parts of the Malayan area?
2. What do you think would be the wisest future commercial policy for the Philippine Republic?
3. Does the extensive cultivation of rice contribute to the continued fertility of the Javanese lowlands?

CHAPTER 51

CHINA

Is ASIA, especially China and Japan, a threat to the economic interests of the western nations, or a potential source of increased business? Many businessmen consider that the Asiatic continent, because of its tremendous population, offers the greatest trading possibilities of all continents. If per capita trade figures are indicative, the outlook for China is hopeless, for its trade is only about one dollar per capita From the viewpoint of the market potentialities as a whole, however, the possibilities are strikingly different, for China's trade has exceeded \$1,000,000,000 annually. Prior to 1895, or before its "westernization," Japan's foreign trade averaged annually about \$85,000,000, but since Nippon's industrial development its imports have been as high as \$1,000,000,000, and its total foreign trade nearly \$2,100,000,000 How this phenomenal increase has been achieved will be explained in the next chapter. It naturally leads to the question of whether China will ever duplicate or even surpass Japan, for China has five or six times the population of Japan.

Population numbers and densities are important in trade, but these alone will not make a country economically great. Despite the age of China, its large area, large population,[1] and its agricultural and natural resources, it has remained a country whose people have not realized the full economic possibilities of some aspects of their environment. Other powers, European, American, and Japanese, have been largely responsible for its present trade. Today, its people and the country remain essentially agricultural, and any economic expansion beyond this has come largely as a result of efforts expended by other peoples. Foreign boats carry its products, foreign capital has constructed its railroads, foreign companies control many of its valuable and essential raw materials, resources, and markets. It is a country whose present progress depends upon the ingenuity, enterprise, and initiative of foreigners, and to these countries China is a storehouse of raw materials and a market for their manufactured products.

Cultural diffusion between China and the Occident, until recent centuries, had been very slow. Mountain barriers to the south and southwest, deserts and warlike nomad tribes to the northwest, and the tremendous length of the ocean voyage to Europe and America have retarded, although not prevented, the interchange of culture. Modern means of transportation and communication have speeded up cultural diffusion and have exposed China to the good and bad influences of an aggressive Occidental culture.

The Environment

Topography. High mountains, forming almost a semicircle to the west of China, were largely responsible for the former Chinese isolation. Other mountain ranges subdivide the lowland plains on which most of the Chinese people live and have thus contributed to Chinese disunity. These mountains radiate out from the massive block of ancient rocks which makes up the lofty Tibetan Plateau. A wide spur from the northwestern end of this plateau, the Tien Shan,[2] incloses the northern side of the basin of Chinese Turkistan. Another spur from the northeast end of the plateau, the Nan Shan, continues to the northeastward to form the Great Khinghan Mountains of Manchukuo. To the east, the Tsinling Shan separate the North China plains from the plains of

[1] Population estimates for China vary greatly and no accurate census has ever been made The Post Office in 1926 estimated China's population at 486,000,000 exclusive of outer Mongolia and Tibet The Maritime Customs figure for 1930 was 444,000,000 and in 1937 the Ministry of the Interior estimated China's total population to be 466,000,000.

Various nonofficial estimates have also been made of which a few are listed below:

Dr. D K. Lieu (1930) .	470-480 million
Warren H. Chen (1930) .	445 million
Walter F. Willcox (1930)	323 million

These estimates should be reduced about 30,000,000 to allow for the separation of Manchuria (Manchukuo) from China since they were made.

[2] *Shan* in Chinese means mountain or mountains It is also useful to know that *Kiang* (in south and central China) and *Ho* (in northern China) are the words for "river." It is consequently not correct to speak of the Hwang Ho River as this is the same as saying the "Hwang River River."

the Yangtze Valley. To the southeast, a broad mountain area extends out in two arcs so as to inclose on the south, first, the great Szechwan Basin and, second, the basins of the central Yangtze. South and southwest of this last mountain area is the calcareous Yunnan Plateau.

Between several of these mountain fingers are the great alluvial plains of China, each associated with a river system, and largely built by it. The greatest of these is the North China Plain, whose yellow soils have been built up on a former sea bottom by the Hwang Ho and, in the north, by the Pei Ho. In central China, the tripartite Yangtze Valley consists of three lowland areas: the delta, the central basins, and the Szechwan or Red Basin. The first two are similar in origin to the North China Plain, but the Szechwan Basin is a much-dissected, hilly area with only occasional small plains. The third important river system is the Si Kiang which forms a fertile delta around the city of Canton. This is the smallest of the major plains, but its all-year growing season, plentiful rain, and rich soil allow it to support a tremendous population (as high as thirty-five hundred persons per square mile).

Natural Resources. Complete surveys of the mineral resources of China are lacking and the following statements are based only on estimates. Although coal and iron ore are important resources and are present in satisfactory quantities from the standpoint of present needs, the country's mineral wealth has, nevertheless, been greatly overestimated. China's coal reserves exceed those of Europe, but most of the few producing mines are under foreign control, while the greater part of the unused coal reserves are far distant from transportation facilities and located in inaccessible mountainous regions. China's commercial iron-ore resources are estimated to be one-fifth of those of the United States, but here, again, a foreign country, Japan, controls the principal workable deposits. China's iron-ore deposits are not rich, nor are they advantageously situated in relation to coking coal. The mountainous areas of southern China also contain considerable copper, lead, zinc, tin, antimony, and tungsten. The country produces almost 75 per cent of the world's antimony and more than 50 per cent of its tungsten.

Water power is almost unused in China. Most of the available power is in sparsely settled, rugged areas. The development of reservoirs and power plants would undoubtedly aid in preventing destructive floods in the valleys and would increase the possibilities of industrial expansion. However, the demand for power is at present so limited that such projects are unlikely in the near future.

The forest resources of China have been destructively exploited in the past so that, except for those in the remote areas of the northeast and southwest, the country is lacking in this resource. It is not uncommon for the Chinese to use brush, rice and wheat straw, and kaoliang stalks for heating and cooking.

China's present supplies of natural resources, with the exception of forests and petroleum (of which no known reserves exist), appear to be adequate for the existing demand. They are not of sufficient size or accessibility to warrant any great immediate industrial expansion, although had China matured more rapidly economically, it might have extended its transportation facilities to the unused reserves and even retained control over the present commercially important ones. It is essentially due to the country's slow development and almost primitive economic state that China has failed to realize any opportunity it has had for becoming an important industrial nation.

Climate. China's climate is strongly influenced by the monsoonal conditions which so largely control the climate of the whole of Asia. The low pressure area over the continent in summer draws the wind in off the Pacific Ocean and the China Sea and usually brings rain to most of the country. This rainfall is heaviest in the southeast where the mountains wring between forty and ninety inches from the moisture-laden monsoon winds. Rainfall decreases in general from south to north and from the coast inward. More than eighty inches fall on the south coast and slightly less than twenty inches a year on the coast of the Yellow Sea in the north. Tibet and Mongolia have less than twenty inches in most places and, in some, less than ten inches.

Although winter cyclonic storms bring some moisture to China, the large portion of the rainfall, almost everywhere, falls during the summer months. The dependence on the monsoon is unfortunate, at times, for, as in India, monsoon rains fluctuate from year to year and in the portions of the country where the average is less than thirty inches annually, wide departures from the average bring about drought and famine.

Almost all of the inhabited portions of China have a hot summer with average temperatures for July ranging from 75° to 85° F. North of 35° N., the January temperatures are everywhere below freezing and the more northerly interior has very cold winters. The dry, cold, antimonsoon winds blowing down from the high pressure area over the interior of the

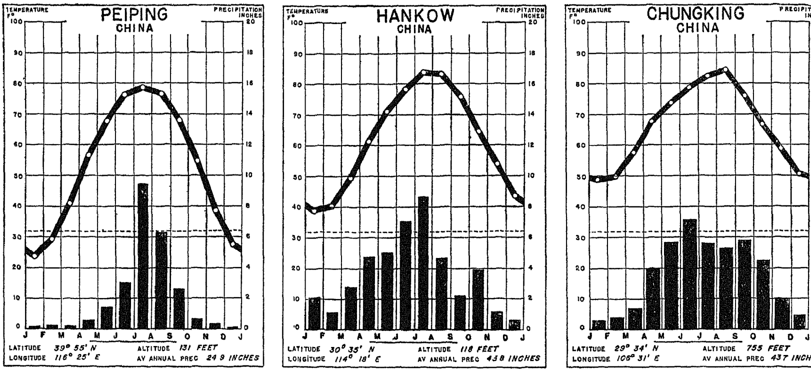


Figure 288. How suitable is each of these climates for the usual Chinese agricultural practices?

continent in winter give northern China, for its latitude, unusually cold conditions.

Occupations

Agriculture. Only 30 per cent of the area of the eighteen provinces which belong to agricultural China is available for cultivation. Of the total area, 40 per cent cannot be utilized because of relief, 5 per cent is too cold, 5 per cent is too dry, and 5 per cent has soil too poor for tillage In addition, much of the arable land is unavailable, since it is used for house sites, roads, grave mounds, and similar uses. On the remaining land, the Chinese have, for forty or more centuries, pursued an intensive agriculture with multiple cropping, heavy manuring, crop rotation, diking, terracing, and irrigation. This technique has already been described on page 153. Considering the great densities of population, the small per capita land holdings (often less than one acre), and the high crop yields obtained, it is a tribute to the Chinese farmer that soil exhaustion is so rare and continued yields so persistent.

In general, China makes little use of modern farm equipment and for that reason the Chinese farmer cannot afford to farm the marginal lands. Each individual farmer is, therefore, operating on a subsistence level and only those few, with larger land holdings, who are farming unusually fertile patches and are close to the market or means of transportation can produce and market surpluses.

The Chinese peasant also differs from the American farmer in relative lack of domestic animals. However, chickens and ducks are common throughout China and a few are found on almost every farm; hence eggs are an important export. Large domestic animals are found in great numbers only where the environment is poorly suited to crop production. Swine are fairly common, for they can feed on the garbage and other refuse and use but little that might be human food. Work animals are also well distributed, although in many sections man is the cheapest beast of burden. Where the peasants can afford them, water buffalo are used in the south, and oxen, horses, and mules in the north. These animals were also used to draw the heavy carts, which once carried the overland freight of the North China Plains and which are still important away from the canals and railways.

The individual crops vary greatly according to the region and are therefore enumerated in the regional description. Although as in all areas with low standards of living a large proportion of the produce is consumed by the farmer's family, nevertheless an important part of the produce of the less isolated farms enters into commerce. Tea, raw silk, soybeans and bean cake, vegetable oils, eggs, cotton, and many minor products serve as raw materials for Chinese industry and are exported.

Industrialization. In many ways China could be expected to be more advanced, industrially, than it is today. The huge population and its low standards of living should have provided a large cheap labor supply. The early history of the country is replete with accomplishments and inventions which

should have been sufficient for the development of skill and engineering techniques. China also possesses the basic resources—iron ore, coal, and limestone—and produces considerable raw materials Why, then, has not China matured into an industrialized economy and utilized the potentialities of its environment?

Although China has probably more people engaged in manufacturing than the United States, most of them are engaged in "cottage" handicraft industries and small village workshops rather than modern factories. The extension of the factory system has probably been handicapped most by the lack of a strong, stable central government. Such a government in Japan was largely responsible for the rapid growth of Japanese industry. Without such a government, foreign capital hesitates to establish factories except in the seaport cities where there are foreign concessions, protected by foreign warships. The weakness of the Chinese Government can be traced to the lack of good communication between the various parts of China, the lack of a universal nationalistic spirit, and to the varied and often mutually incomprehensible dialects into which the Chinese language is divided. The isolation of many of the Chinese people from the main arteries of transportation and the great size of China have made it extremely difficult for western ideas to penetrate the interior. Many of the Chinese cities along the coast are almost as progressive in industry and municipal government as those of Japan, but they are hampered by the unprogressive hinterland.

The leading modern manufacturing industries in China are the textile industries (cotton and silk), flour milling, iron and steel and their products, shipbuilding, tobacco products, boots and shoes, printing and publishing. These industries (with a very few exceptions) are located in the large seaports or the major cities of the lower and central Yangtze Valley, where there is contact with the streams of international trade.

Foreign Trade. Evidence of trade with foreign nations dates from the last century B.C., but such trade was not of any real significance until the sixteenth century A.D., when trade with Europe was regularly established. Until the last century most of the trade of China was in exports, for isolation led to a suspicion of foreign-made goods and self-satisfaction with local products. This attitude is still common in many of the interior sections of the country and has been largely responsible for the undeveloped nature of this huge potential market. Throughout the whole

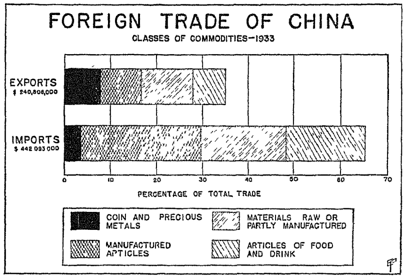


Figure 289.

foreign-trade history of China the lack of interest in "foreign goods" has necessitated the introduction of new and bizarre products so that imports might be increased. At one time ice was actually shipped from the United States to south China and exchanged for tea and silk. The great preponderance of export trade necessitated large payments in silver by foreign nations, and even though the balance was better at the outbreak of the recent Sino-Japanese War, the trade of the country still fluctuated greatly with international exchange rates.

China's export trade originally consisted of tea and silk, but in recent decades there has been some export of manufactured goods, especially of cotton, and a slight rise in the export of foodstuffs. Other exports include raw materials—such as hides and skins, wool, coal, iron ore, and vegetable oils.

China's imports are almost entirely limited to cheap products, as a result, nations with low costs of production hold a considerable competitive advantage over countries like the United States which have high labor costs The principal articles of import are manufactured goods, textiles, oils, machinery, tobacco, paper, and foodstuffs (rice, sugar, flour and wheat).

QUESTIONS FOR DISCUSSION

1. Compare the Yangtze Valley with the Mississippi Valley as to size, latitude, climate, relief, etc. (Use an atlas.)
2. Will increased industrialization affect the standards of living of the Chinese people? How? Why?
3. Look up in the *Foreign Commerce Yearbook* the trade of China with the United States. Account for the importance of the leading exports and imports.

Regional Geography

It is a common fallacy in considering the problem of a foreign country to consider that country as a

unit. China, for example, is often spoken of as a country suffering from overpopulation, yet the average density per square mile is one hundred and twenty people which could hardly be called overcrowding if mere area, alone, is considered. However, an analysis of China by regions, such as is shown in Fig. 290, makes it evident that the population is not evenly distributed over the total area and that certain parts of China are very densely populated. In the North China Plain, for example, the population density is so high and the average annual rainfall so close to the margin that a slight seasonal deficiency in precipitation might bring on a serious famine. Figure 290 also shows that overpopulation must be considered in relation to resources. For example, the barren Tibetan Plateau with its small resources and very sparse population is, by many authorities, considered more nearly overpopulated than the Yangtze Valley with its dense population, moderate rainfall, fertile soil, and long growing season.

North China Plain. Yellow, derived from the wind-blown loess from the deserts of Mongolia, is the principal color of North China. This dust, mixed with alluvium from the rivers, forms the prevalent light, calcareous, fertile, yellow soil. It is also suspended in the streams—hence the name Hwang Ho (Yellow River)—and these streams flow into the Hwang Hai (Yellow Sea). The houses are built of brownish-yellow clay, and even the Imperial Palace at Peiping is roofed with tiles of yellow, the imperial color. Frequent dust storms in dry periods fill the air with yellow dust which covers the faint green of the drought-stricken crops.

Unfortunately, the fertile soil has resulted in a prolific population rather than in prosperity. Ninety per cent of the people are dependent on agriculture, and this agriculture is dependent on a precarious rainfall. At Tientsin, for example, the rainfall for June (the most critical month for spring crops) has varied from below one-quarter inch to above eight inches. The dry years bring drought and famine, the wet years bring floods which—by washing away the crops—may also bring famine. The drought is especially serious, because most of the crops are not irrigated. Floods are a constant threat, for the Hwang Ho has built its bed above the level of the plain and is held to its course only by natural levees, artificially reinforced. Heavy rains, or the neglect of levee repairs due to political disturbance, may cause the river to break loose. This is not unexpected by the peasant, who builds his hut on a mound which, he hopes, will stay above the floodwaters. Rare is the year when thousands of peasants on some part of the plain do not perish either from drought or flood.

The cold winters discourage winter crops, although some winter wheat is grown. Corn, barley, kaoliang,

Figure 290[1]

AGRICULTURAL SUMMARY OF CHINA BY GEOGRAPHIC REGIONS

Region	*Population per square mile*	*Per cent of area cultivated*	*Growing season (days)*	*Average rainfall (inches)*	*Per cent of cultivated land in each crop*				
					Rice	*Wheat*	*Millet*	*Kaoliang*	*Beans*
North China Plain	647	66	200	20-30	..	30	15	15	15
Loess Highlands	211	17	175	15-20	..	25	30	15	15
Mts. of Jehol and Shantung	250	20	175-200	12-25	..	25	15	15	15
Central Mountains	290	15	250	30-40	15	25	10	5	10
Yangtze Valley	897	71	300	35-50	40	25	..	..	10
Szechwan Basin	581	39	325	35-40	30	15	..	..	10
Hills and Small Plains of So. China	367	15	300-365	45-80	60	10	..	..	5
Yunnan Plateau	157	4	325	35-40	40	15	..	..	10
Tibetan Plateau	under 2	very small	0-125	5-20	..	?	?	?	?
Chinese Turkistan	2	oases only	100-160	2-10	?	?	?	?	?
Mongolia	under 2	very small	100	5-10	..	?	?	..	..

[1] George B Cressey, *China's Geographic Foundations*, Table XXXVI. McGraw-Hill Book Company, New York, 1934, and the *Encyclopaedia Britannica*. Many of these figures (as with all Chinese statistics) are but little better than estimates.


SCALE OF MILES
0 100 200 300
MONGOLIA
THE GOBI
ORDOS DESERT
LOESS HIGHLANDS
MTS OF JEHOL
MANCHUKUO
Mukden
KOREA
Peiping
Tientsin
Dairen
NORTH CHINA PLAIN
MTS OF SHANTUNG
HWANG HAI OR YELLOW SEA
HWANG HO
TIBETAN PLATEAU
CENTRAL MOUNTAIN BELT
SZECHWAN BASIN
YANGTZE KIANG
Chungking
Hankow
Nanking
Shanghai
YANGTZE PLAIN
HILLS AND SMALL PLAINS OF SOUTHERN CHINA
YUNNAN PLATEAU
SI KIANG
Canton
Hong Kong
TROPIC OF CANCER
TAIWAN
FRENCH INDO CHINA
30
120
20
110
CHINA
KEY
MOUNTAINS
HILLY REGIONS
PLATEAUS
PLAINS
DESERTS
REGIONAL BOUNDARIES

Figure 291.

cotton, tobacco, and sweet potatoes are among the summer crops. Millet is invariably included, because it is the last crop to be affected by drought. Usually there is a small irrigated vegetable garden, and one or two draught animals are kept.

The low standard of living of the peasants, even in good years, is almost incredible. They have no reserve except their tools and animals. Even these may have to be sold in bad years in order that the owners may buy food. The land may either be owned or rented, but has no value in periods of famine. The mud huts contain nothing of value except the wooden joists and the wooden doors. Food is adequate only in the best years and it is customary for the poor to eat but one or two scanty meals of millet a day during the idle winter season, to enable their sparse stores to last until the next harvest Farms are small—they average four acres, but many are much smaller—and this small area includes the house site, barnyard, pasture, canals, and a considerable area occupied by the ancestral graves. Ancestor worship not only causes a large amount of land and work to be spent on graves, but prevents many peasants from emigrating to the new lands of Manchuria.

The two cities of the plain are Peiping, the former Chinese capital, and Tientsin, the principal port of the area The former is at present but a cultural center, based on memories of China's past, for Peiping has few advantages of position or resources. Tientsin, on the other hand, is a river port, forty miles from the sea, but accessible by small ocean vessels. It is at a convenient junction of rail and water routes, and can handle considerable of the Chinese overland trade with Manchukuo. The cheap labor of the surrounding plain has been used to start a few simple industries, such as cotton manufacturing.

Loess Highlands. The highland west of the North China Plain has been covered with a layer of fertile yellow loess which often reaches a thickness of several hundred feet. The topography is irregular, and less than one-tenth is level land. These limited farmlands have been supplemented by cutting terraces into the loess hillsides. Dry farming is commonly used, because the streams which supply irrigation water often flow in deep canyons. Drought-resistant millet is the common upland crop, but a great variety of fruits and vegetables is grown in the limited irrigated valley plains. Opium poppies are common, since their valuable product can stand the long trip to market.

Floods are not a serious menace in the highlands and drought is not so devastating, because of sparser population, the water-holding capacity of the soil, and the widespread use of drought-resistant crops Wool sheep, cattle, and poultry (for egg export) supplement the income from crops. The greatest danger in the region is from frequent earthquakes. These are especially serious, since most of the peasants live in houses hollowed out of loess cliffs These houses collapse when earthquakes occur, and in some sections more than three-quarters of the peasants have been buried and killed in a single earthquake.

This region contains many unused resources which remain undeveloped because of isolation. Coal of good quality—possibly equal to that of Pennsylvania—underlies much of the loess, and other minerals may be discovered. The hilly lands once supported a good forest growth and could again be planted—thus both benefiting China's timber supply and lessening the devastating Hwang Ho floods.

The Mountains of Jehol and Shantung. These areas of old rocks contain much barren land, suitable at best only for forests or pasturage. The people are to be found mostly in the small fertile valleys which penetrate the region and which are but a continuation of the farmlands of the North China Plain. Jehol is a pastoral mountain area which serves as a barrier between Manchukuo and China. Shantung is less rugged and has a considerable industry in producing pongee silk. This is obtained by feeding oak leaves to the silkworms instead of mulberry leaves. An important mining industry is based on the thick veins of coal which overlie some of the ancient rocks in the western part of Shantung.

The Central Mountain Belt. These mountains are more important as a barrier and a boundary than as a region. They separate the south of China with its humid subtropical climate and crops of rice, tea, mulberry, and bamboo from the north with its loessic soils, droughts, cold winters, and dominant crops of wheat, millet, kaoliang, and beans. The southern spur of this mountain belt separates the lower Yangtze Valley from the Szechwan Basin by a barrier which has been overcome only by hazardous river navigation through some of the wildest and most beautiful river gorges in the world.

The mountains become lower from west to east. The Tsinling Shan in the west rises to twelve thousand feet and is almost uninhabited. In the east, the mountains are hardly more than high hills and are interspersed with broad valleys—notably that of the Han—which have a dense agricultural population.

The Yangtze Plain. The plain of the lower and central Yangtze is exceptionally level, and only villages, grave mounds, and a few trees break the sky-

line. Although the region contains the majority of the large Chinese cities, two-thirds of the people live by agriculture. A fine network of canals divides the alluvial plain into many patches, and muddy irrigation water supplements the night soil of the villages and cities in maintaining the fertility of the land. The fields are always in use and three crops a year are common. Wheat, beans, rapeseed, and barley occupy the land in winter and are grown as dry crops, rice, cotton, peanuts, and other subtropical crops are grown in summer, usually by irrigation. A third crop of rapid-growing vegetables is often obtained between seasons In the Yangtze Delta another product—the mulberry tree—becomes important. Often, these border the canals or irrigation ditches and are fertilized with rich canal mud. The dense population of the plain provides the cheap labor supply needed to harvest the mulberry leaves and care for the silkworms.

Unlike so much of China, the Yangtze Plain is fairly well provided with transportation. The Yangtze Kiang is navigable by 10,000-ton vessels as far as Hankow (630 miles upstream) and smaller river steamers penetrate into Szechwan Basin. Canalboats and junks afford communication away from the main stream, and the canal system almost replaces through roads. The railway lines do not attempt to compete with the river system, but depart from the river at right angles and connect the plain with adjacent regions, especially to the north.

Cities. Excellent transportation has resulted in large and modern cities, including Shanghai (3,350,000 population), Hankow (1,600,000), Nanking (622,000), Soochow (500,000), Nanchang (480,000), Hangchow (650,000), and Ningpo (450,000). Modern factories, telephones, electric lights, motion pictures, and other Occidental features are common in these and other large Yangtze cities. Of these, Shanghai, located on a tributary of the Yangtze fourteen miles from its month, is the commercial and industrial leader. Its importance is due to its position where the trans-Pacific routes meet the Mediterranean-Suez-Indian Ocean-Singapore-China Sea route and to its rich Yangtze Plain hinterland. In 1929 it had 1781 modern factories which included half the cotton-textile mills of China. Rice-hulling factories, silk-weaving plants, leather factories, paper mills, canning plants, cigarette factories, foundries, printing establishments, and shipbuilding yards were also important. Many of these plants were controlled by foreign capital—especially Japanese and British.

Figure 292 This map shows the main canals in an area of 718 square miles about 50 miles southwest of Shanghai. (From F. H King, *Farmers of Forty Centuries*, Harcourt, Brace)

Szechwan Basin. This basin, almost entirely hemmed in by high mountains, was occupied by a lake in former geologic times. The Yangtze River cut headward through the Central Mountain Belt, drained the lake, and started the dissection of the basin. Thus, the present hilltops in the basin represent the old lake bottom while 1000 to 1500 feet below are the valleys cut by the four streams which unite to form the Yangtze (the name Szechwan means "the Four Streams"). Thus, the basin is not level except where the rivers have cut wide valleys at a few places such as the Chengtu Plain. However, the climate is so favorable to intensive agriculture that the farmers have terraced the hillsides. Although, in most of

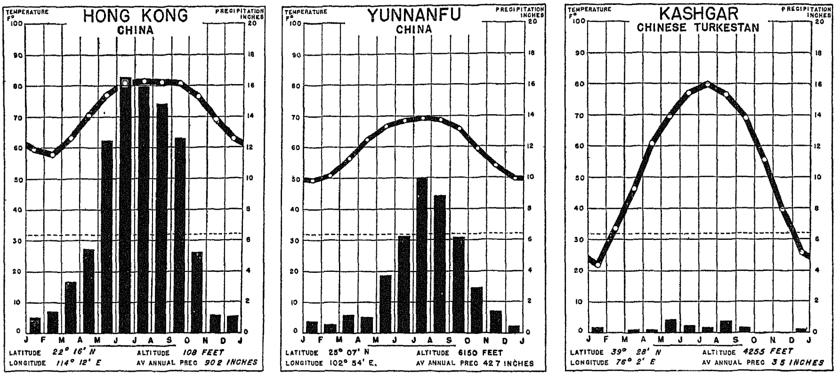


Figure 293 The monsoon influence, although visible in each chart, decreases toward the interior

China slopes of more than 20 degrees are neglected, here hills of 30 degrees are terraced from top to bottom, hills of 45 degrees are partly terraced, and terraces on a 60-degree slope are not unknown.

The climate is warm and humid, and the sheltering mountains keep out the cold winter winds which sometimes blow over the Yangtze Plains. Hence, such subtropical crops as oranges and sugar cane can be grown The staple crops, however, are rice, winter wheat, cotton, hemp, tobacco, beans, opium poppies, tea, and the mulberry.

Szechwan has been rated by many travelers as the most attractive and most productive province of China. However, its roads have until recently been but paths or mule tracks and its rivers are filled with rapids and whirlpools River steamers penetrated to Chungking and in high water much further up the Yangtze. But the transportation was so poor that the exports were limited to salt, tea, silk, opium and other products which were valuable in proportion to their bulk and weight.

The Japanese conquest of the Yangtze and North China Plains has forced the Chinese Government to move its capital to Chungking, an ancient city which is now rapidly being modernized. A road has been built from Chungking across the Yunnan Plateau to Burma, and other routes are being improved. Schools and factories have been moved from the coastal cities to Szechwan and thousands of educated Chinese, familiar with Western techniques, have been added to the population of this formerly backward province. Possibly the coal, iron, and other resources of Szechwan and Yunnan may be used to build a stronger and more unified Chinese nation.

QUESTIONS FOR DISCUSSION

1. Examine Fig. 290. Does there seem to be any relation between the density of population and the amount of rainfall? between the density of population and relief? between the density of population and the length of the growing season? Does the total environment give a fairly satisfactory explanation of the distribution of population in China? What other factors may enter into a complete explanation?
2. The capital of China is now Chungking Is this city better suited than Peiping to be the capital of China? What geographical factors might be advanced to favor its selection?
3. How have winds influenced the agriculture of North China?

Hills and Small Plains of South China. South of the Yangtze Plain is a gigantic block of mature and old mountains which have been so eroded that their summits rarely exceed 5000 feet and much of the area is below 2000 feet. The eastern edge of the mountain block has been partly submerged, forming numerous harbors along a rocky coast. These sheltered bays and the timber on the near-by mountains have turned the attention of the people to the sea, for the areas of good, level land are very limited. Along this coast are the chief fisheries of China and the home ports of many of the Chinese junks. From this coast have emigrated Chinese sailors and merchants, for the people do not feel bound to the soil as does the peasant of the northern and central plains.

Inland the population occupies the narrow valleys,

which are planted with tea bushes, mulberry trees, or orange groves. The higher hillsides are neglected for the most part, and their forests of pine, oak, fir, camphor, and bamboo constitute China's only considerable timber reserve The cost of local transport is so great that this lumber can rarely compete with that of Oregon and Washington in the major Chinese cities.

The mountain block is well supplied with minerals, most of which are mined, if at all, by very crude methods Coal, iron, lead, zinc, manganese, bismuth, tin, antimony, and tungsten are known to be present, but only the last two are of importance in world markets.

Canton Delta. The valley of the Si Kiang, including the delta about Canton, is the only large plain in the region. It is just within the tropics and its growing season lasts throughout the year. Rice, sugar cane, sweet potatoes, oranges, ginger, mulberry trees, and tea are the products of the Canton Delta and the adjacent low hills. Perhaps no other large area is so intensively farmed.

Canton is the metropolis of the area Many of its citizens have been abroad to the East Indies, Malaya, the Philippines, or even the United States, and have brought back foreign ideas and foreign earnings which have aided the progress of Canton. Although Canton was the first Chinese city to engage in sea trade with India and Europe, its place as the leading seaport of the south China coast has been lost to Hong Kong, a British island at the mouth of the Delta. This is due largely to Canton's shallow harbor, which at low tide is only six feet deep. At present, more than 90 per cent of the sea-borne trade of Canton is transshipped through the free port of Hong Kong.

The Yunnan Plateau. This young, dissected plateau is a spur of the high Tibetan Plateau, but its average height is only between 5000 and 7000 feet. In spite of its subtropical latitude, its elevation gives it a stimulating temperate climate. This, added to a large supply of minerals, would suggest that it ought to be one of the most progressive parts of China. However, isolation, caused by canyons several thousand feet deep and ranges 4000 feet above the plateau level, has made this one of the most backward parts of the country. Until the construction of the railroad from French Indo-China to the provincial capital, Yunnanfu, it required four months to travel from Peiping to the capital of Yunnan Province.

Very little of the plateau surface is level, especially in the east where the streams have almost completely dissected the upland. The small upland plains, including the bottoms of several former lakes, are rich agricultural areas. These limited areas are in the hands of the Chinese immigrants who make up about half of the population. The rest of the plateau is inhabited by aborigines who are racially related to the people of Siam and Indo-China. These live by herding, hunting, and primitive farming and contribute but little to the trade of the area.

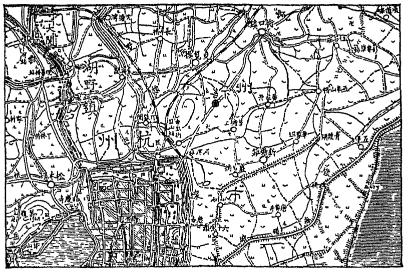


Figure 294. An area of coastal plain formed by river deposits south of the mouth of the Yangtze. Mulberry cultivation is indicated by a small v, rice cultivation is indicated by a thin horizontal line under two vertical lines (From a Chinese General Staff map, reduced to a scale of 1/130,000)

The mineral resources of the plateau are varied, but tin, copper, lead, and zinc are the principal minerals utilized. The French railroad was built in part to tap some of these resources, especially tin which is lacking in the French colonial empire. Dense forests are found in the wilder parts of the plateau, but lack of transportation prevents the development of these as it does most of the mineral resources.

The Tibetan Plateau, Sinkiang and Mongolia. These areas, large in area, but with scanty resources and few people, are sometimes referred to as the "backdoors of China." Nominally, they are under Chinese control, but, actually, distance from the political centers of China has given them almost complete independence. Except along the caravan routes, these lands have never been completely explored, and the boundary lines are but convenient generalizations on the map and have little practical significance except where they touch on an adjacent settled area such as India.

The Tibetan Plateau is everywhere more than 10,000 feet in height and the cold climate forces the natives to wear heavy felt or quilted garments the

year around. Agriculture is limited to a few valleys, especially in the southeast, and barley and potatoes are the only crops suited to the short growing season. Around the agricultural villages, and often connected with them, are nomadic peoples who graze their yaks and goats wherever some sparse grass may be found on the barren mountain sides. Usually, the herds move up and down the mountain slopes according to the season, for the grass is so sparse that they cannot stay long in one place.

Sinkiang or Chinese Turkistan is a basin surrounded by a horseshoe of snow-capped mountains. Streams from these mountains feed a string of fertile oases which produce a great variety of subtropical and temperate crops. The area is of almost no commercial importance today, but before water routes were opened to China its oases were supply stations on the main caravan route connecting China and Mediterranean Europe.

Mongolia is a vast, featureless desert plain (the Gobi) surrounded by a ring of semiarid lands which may eventually be used for dry farming. The Mongols, once the terror of Eurasia, are now a relatively peaceful pastoral people with huge herds of cattle, sheep, horses, and camels. Politically the area is more important than it is economically, for it is a buffer area between Japan and Russia. Outer Mongolia is now an independent republic under Soviet auspices, while Japan has recently started to detach Inner Mongolia from China. Meanwhile, as has been the practice for several centuries, long caravans cross Mongolia carrying the Chino-Russian trade, especially in tea.

The heart of Asia seems destined to remain barren and almost uninhabited unless some vast mineral treasure should be discovered there. The available irrigation waters have been used for ages, and the scant trade of the backdoors of China hardly justifies railroad development. Several transcontinental railroad routes have been proposed, but it hardly seems likely that they will be developed except, like the Trans-Siberian route, for military or political reasons.

QUESTIONS FOR DISCUSSION

1. Which regions of China seem to have the greatest possibilities for future economic development? Why? What specific steps would you suggest to lead to this development?
2. Why have minerals such as antimony, tungsten, copper, and tin been exploited in China more than the coal and iron resources?
3. Compare China with similar latitudes in eastern United States What are the most striking differences and similarities, latitude for latitude?

ANALYSIS OF PLATE XXII: CHINA

XXII A. This is a typical scene in the moist rolling lands of southern China The hills are, perhaps, better forested than is common, for this land surrounds a shrine. Timber is, however, much more plentiful in southern China because of the greater rainfall and the warmer temperatures which cause a smaller demand for fuel The relatively good state of the "road" is also probably accounted for by the fact that it is the approach to a shrine. Human carriers are, however, the only possible means of transport on such "roads" because of their narrowness and the steep grades which at one place here are negotiated by steps. The stream which falls rapidly down the little valley at the left is made to water each terrace in turn and, finally, the large rice paddys at the bottom In addition, it supplies water for the ponds in which fish are raised.

XXII B On the Delta of the Yangtze, the network of canals serves as the main means of transport Here each house has its landing on the canal and many families live all their lives on boats such as those tied up at the right. They eke out an existence by carrying goods, fishing, scavenging, and working as migratory laborers

XXII C In its course from the Szechwan Basin to the sea, the Yangtze cuts its way through the Central Mountain Belt in a series of gorges. During the dry winter, the river is often low enough to interfere with navigation by large steamers. The large foreign companies using this waterway throughout the year have developed fleets of shallow-draft boats.

XXII D Hundreds of thousands of square miles in western China are covered with deep deposits of loess, probably brought by the winds from the desert lands still farther west It is rich, but lacks rainfall enough for cultivation over much of its area. This loose, fine soil is easily eroded. Some authorities believe that there is moisture enough here to grow some types of trees and this would add to the fuel and timber supply and help to anchor the soil and reduce floods

XXII E. The graves of his ancestors are such objects of veneration to the Chinese that, in spite of the scarcity of land, they must be maintained as close to his dwelling as possible In this picture taken on the North China Plain, there are ornate mounds in the distance and more simple ones in the foreground Grain is grown among the mounds, but they take up much land which, in this crowded country, might be profitably used for the production of food for the living.

CHAPTER 52

JAPAN, KOREA, AND MANCHUKUO

JAPAN ("Nippon," official title) is, judged by Occidental standards, by far the most advanced country in the Far East In spite of an exceedingly limited physical environment, which has restricted its supply of raw materials and food, Japan has had sufficient human resources to enable it to become the most progressive Asiatic power as well as an economic threat to the older industrial centers of Europe and North America.

The ancestors of the present Japanese people were a group of rice-growing people, closely related to the Chinese. It is thought that they moved into the southern portion of the Japanese Archipelago before the beginning of the Christian Era. Gradually they conquered the aboriginal inhabitants (Ainu) and replaced the aboriginal hunting and fishing economy with an agricultural economy. After a period of almost complete isolation from the cultures of the mainland, the Japanese renewed close cultural relations with China and learned silk manufacturing, ideographic writing, paper making, and Buddhism. In spite of these contacts, the relative isolation of the islands permitted the Japanese to develop a unique civilization which is sharply differentiated from its Chinese godfather. Japan became a feudal area, ruled by paternalistic war lords; thus the Japanese developed a strong military tradition associated with a great pride and a strict code of honor. Art, courtesy, and careful use of the limited resources also were ingrained in the Japanese tradition.

In 1542, Japan had its first important contact with the European world when Portuguese traders and, some years later, Dutch merchants, obtained trading privileges. But as these relations did not prove satisfactory to the Japanese, Japan soon dropped almost all contact with the Occidental world.

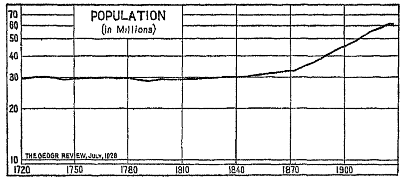


Figure 295. The population of Japan has increased steadily and rapidly since its opening to relations with the Western World. Semi-logarithmic scale (Courtesy of the *Geographical Review*, published by the American Geographical Society)

Several centuries later (1854) Commodore Perry, of the United States Navy, practically forced the conclusion of a commercial treaty between Japan and the United States. Other treaties were soon drawn up with the major powers of Europe, and Japan's seclusion was ended. Realizing that aggressive European nations could only be defeated with their own weapons, the Japanese Government reversed completely its policy of isolation by sending representatives to learn the arts and sciences of the West.

As a result of the new knowledge, an exceedingly rapid change occurred—a change, however, which involved material things and altered the spiritual and moral traditions of Japan but slightly. In three-quarters of a century, Japan emerged as a world power —a nation that has the third largest navy in the world, one that has defeated both Russia and China in war, a country that holds an important place among the great nations of the world. The transition from an isolated country to a world power was rapid because it was aided by the presence of an energetic population, by necessity, and by a paternalistic government.

ANALYSIS OF PLATE XXIII: JAPAN AND MANCHUKUO

XXIII A. Here there is a complete use of all land. Note the continuous line of rural dwellings between the rice lands on the valley floor and the mulberry growth on the slopes above

XXIII B. In this district, slopes are gentler and even the rolling lands may be used for rice with a little terracing.

XXIII C. Winters are severe in Hokkaido and the warmth-loving Japanese are reluctant to migrate there, even to modern cities such as this.

XXIII D. Flat lands, rich soil, and sparse population have encouraged machine agriculture in Manchukuo.

XXIII E. An example of Japanese industrial expansion

This progressive expansion in Japan brought with it certain acute problems. With the opening of Japan to foreign trade, population growth was accelerated at a tremendous rate (Fig. 295). Furthermore, the contact with the rest of the world accentuated in the minds of an already suspicious people the need for protection from invasion. The army and navy were greatly expanded and this placed a large tax burden on the people. An increasing population brought about the necessity of increasing the food supply. The land area was decidedly limited; agricultural expansion was therefore restricted to a greater intensification. Unfortunately, intensification was not sufficient. Japan had to import food and this implied the production of exportable surpluses to carry on the necessary exchange. Japan has tried to solve the problem by duplicating the development of England more than a century earlier. In her development England changed, successfully, from a nation predominantly agricultural, faced with the same population problem that Japan now faces, to an industrial and commercial nation.

Is Japan the Britain of the East? Japan has often been called the "Britain of the East," but, except for her dense population and her insular position, the differences are more important than the similarities. Japan is not a nation of small extent such as the British Isles, but rather an island empire, consisting of nearly 2000 islands (600 of which are inhabited), that extends from the northern edge of the temperate latitudes to the tropics. Japan has an "east-coast" climate, influenced by the monsoon winds, while Britain has a "west-coast" climate, influenced by the warm North Atlantic Drift and the prevailing westerlies. Furthermore, Japan faces the Asiatic land mass that by no means may be compared to the European mainland with its great economic development and market potentialities.

Environment and Occupations

Topography. Nearly all of Japan is mountainous. Two parallel ranges border the east and west coasts with a central valley between—except where they join in a complex mountainous core in the center of Honshu. Japan with very few large plains areas has been forced to adopt intensive agriculture and terracing of slopes. In all, the plains represent but 15 per cent of the total area, while only one-fifth of Japan's land can be cultivated and 75 per cent of the arable land is already in crops.

Due to the mountainous nature of the islands, the rivers are short and rather swift-running. Such streams are ideal for water power, but are of little use as inland waterways. Fortunately, the irregular coast line of Japan provides not only excellent harbors, but considerable access to the interior. The Inland Sea which occupies much of the central valley in south central Japan, is, in itself, one vast harbor with only slight tides and with few rivers flowing into it to cause silting. It is well protected by mountainous country on both sides and has few disturbing winds and currents.

Climate. Japan's climate is similar to that of the east coastal fringe of China, except that, being insular, it has certain modifications, such as less extreme temperature ranges and slightly greater rainfall. The main group of islands extends from the latitude of northern Florida (southern Kyushu) to the latitude of New England and Nova Scotia (Hokkaido). In the winter, it is influenced by northwest antimonsoon winds that are largely dry except where they strike the west coast mountain ranges and cause winter rainfall. In the summer the monsoon winds, more feeble than the northwest winds, bring rainfall to the south and east coasts.

Agriculture. Fully 60 per cent of the population of Japan is dependent upon agriculture. The nation is more agricultural than any other world power, in spite of its exceedingly small land area suitable to cultivation. Although there are considerable areas of fertile volcanic or alluvial material, many Japanese soils are not naturally very fertile. The damp climate and heavy rainfall favor leaching, and mountain torrents often wash away large areas of soil or else cover rich soils with infertile deposits of gravel. However, careful terracing and intensive fertilization have been used to overcome the natural soil handicaps, so that Japanese crop yields are high, even compared with intensively cultivated China

Rice predominates in Japanese farming and occupies nearly half of the total cropped area. Its high yield per acre, adaptability to hand cultivation and the favorable climatic conditions present for its growth make the crop the chief source of food for the country's rapidly increasing population. This explains why rice acreage increases in direct proportion to Japan's population growth and why the acreage of the other (with the exception of wheat) crops is decreasing.

Other important crops are mulberry trees, tea, barley, wheat, soybeans, peas, and tobacco. Many of these crops are grown either on slopes not suited to rice, in rotation with rice in alternate summers (soybeans,

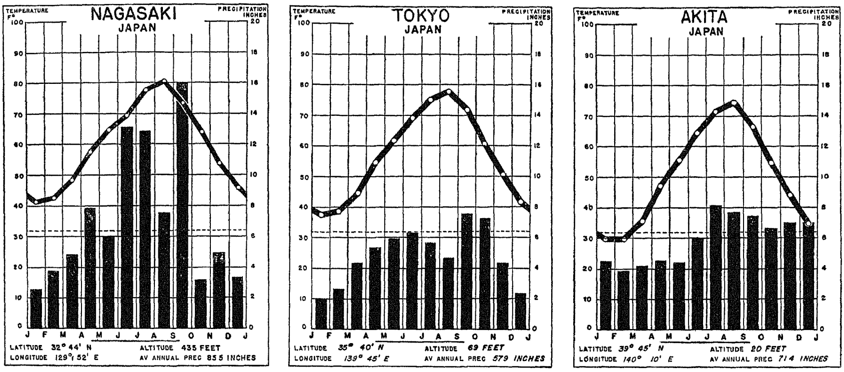


Figure 296

peas), or during the winter season (winter wheat, barley).

Owing to a lack of pasture land, Japan is not a great stock-raising nation. Sheep, goats, and pigs are, however, being raised in increasing numbers. Large domestic animals are not very necessary in the Japanese economy, for milk is little used and fish serve as a meat substitute in the diet.

Forestry. Timber has always been an important resource to Japan. Much of its past handicraft stage of economic development involved the use and exploitation of this resource. With growing industrialization, a shortage seems imminent. The mountain slopes of the nation were at one time heavily wooded, but now Japan imports one-third of her lumber supply (from the United States, Canada, and eastern Siberia). The domestic supply comes from Hokkaido and Sakhalin whose rugged slopes with favorable rainfall should remain in permanent forests. Unlike China, Japan has always carefully cared for its forest resources The trees are varied, with conifers in the north, temperate hardwoods in northern Honshu, and tropical and subtropical trees in the southern half of the archipelago. The rapid-growing bamboo, a tree of the tropical and subtropical regions, is planted in large groves, and its product is ideal for the light style of architecture so characteristic of Japanese homes.

Mineral Resources. Japan, with a commitment to "westernization," lacks sufficient local supplies of coal and iron. The iron-ore deposits are scattered. The total reserves are estimated at 80,000,000 tons, of which not more than 50 per cent are usable, based on present techniques. The resources will hardly last more than twenty-five years, at the present rate of consumption, and Japan already imports huge quantities of scrap steel to supplement the small ore resources. From 1925 to 1932 Japan purchased slightly more than 100,000 tons of scrap steel annually, but by 1936 its imports had jumped to 1,473,000 tons.

Coal deposits, like those of iron ore, are limited. The bulk of the deposits are poor in quality, scattered, and not especially good for coking. The inadequacy of her coal resources is very evident when placed on a per capita basis. Japan has 118 tons per capita; the United Kingdom with approximately the same population has 4070 tons per capita.

Copper is the only metal with which Japan is adequately supplied and it has been the chief metal in Japanese arts since early times. Copper is exported today, both as metal and as part of bronze and brass implements and electrical equipment. The increasing electrification of Japan has, however, practically stopped the export of the metal and, in some years, copper has been imported.

The volcanic nature of many Japanese mountains accounts for the presence of large sulphur deposits. These are important in the fertilizer industries which are so necessary to an intensive agriculture and in the chemical industries which are an integral part of Japanese westernization. As with copper, increasing demand at home and the lower costs of foreign producers have greatly decreased this once important export.

To complete the discussion of Japan's resources it is necessary to consider two other items—water power and petroleum The latter is the third most important mineral product of Japan, and yet it has only a thirty-year reserve. Production is less than one-third of the domestic demand, a situation that has forced the raising and use, in part, of agricultural substitutes such as cottonseed and soybean oils. While Japan does control some oil fields in Sakhalin, the wells are high-cost ones requiring pumping. A further disadvantage is the necessity of great storage facilities, for the ports of this area are icebound nine months of the year.

Water power is one of the most important assets of the empire. High relief and heavy rainfall combine to give it an abundance, particularly in the northern and western areas. The monsoon rains provide abundant moisture, which is supplemented by the winter rainfall of the northwest winds The lakes in the Japanese mountains provide excellent storage facilities, and the topography is conducive to the economical construction of reservoirs The total potential water power available in Japan at "minimum flow" has been estimated at close to 6,500,000 horse power, of which nearly 40 per cent has been developed.

Industrialization. Japanese industrialization faced many other difficulties in addition to the lack of coal and iron. For two hundred years, other countries had been industrializing and most of the profitable markets had already been developed by the older industrial nations. The only answer to this was lower costs of production and, therefore, competition on a price basis To this end machinery was imported, workers were trained, shipping lines were established, and military and naval forces were developed to get and hold foreign concessions. Japan began to reach out into foreign countries for supplies and seized Formosa, Korea, Sakhalin, Manchukuo, and is at present attempting to dominate much of China.

In the early days of industrialization Japan followed the course adopted so recently by Soviet Russia—educating the people and importing foreign machinery and "brains" Today the Japanese have advanced to the point where English and American firms are sending representatives to Japan to study its new production and management methods. Given the background, then, and the reasons for Japan's present policy, it remains to be pointed out how it has succeeded in taking what appears to be the only course open—industrial expansion.

The most important group of industries in Nippon is the textile group, which includes silk reeling and cotton spinning and weaving. Raw materials for these industries are agricultural in origin. The raw silk used in the silk-reeling industry is dependent upon cocoon production and the growth of mulberry trees. Unfortunately, because of limited land area, tree production cannot expand to any great extent. The market for raw silk is limited to countries with high standards of living like the United States which imports 90 per cent of the total Japanese exports of raw silk. Japan's greatest advantage in this particular industry is a tremendous abundance of cheap hand labor which is required to feed mulberry leaves to the silkworms. Unfortunately, Nippon finds great difficulty in expanding beyond the reeling stage and weaving of cheap bolt goods in the silk-manufacturing industry. Silk weaving, for instance, is relatively unimportant in Japan, due to the style element basic to the industry, the country's great distance from the consuming market, the impossibility of creating a near-by market, and tariff restrictions in importing countries.

In the textile fields of cotton and rayon manufacturing, however, the greatest gains have been shown. While Japan grows cotton, it is both inferior in quality and too small in quantity to satisfy its raw-material demands. The bulk of the raw cotton is imported from British India, the United States, and China, manufactured in Japan's modern mills; and exported to China, India, and many other markets.

The rise of Japanese industry is due primarily to the encouragement of the Japanese Government which has trained workers, granted subsidies, manipulated foreign exchange, and in many other ways followed an aggressive policy of industrial expansion. Low overhead costs, new and improved machinery, and efficient marketing are also important contributing factors. Cheap labor, attributed to overpopulation and low standards of living, may be important, but it has been questioned whether its inefficiency does not largely outweigh its low price. Orchard[1] demonstrates that the wage cost per pound of cloth is little lower in Japanese mills than in North Carolina mills, although the Japanese wages are about one-fourth the American standard. But further depreciation of the Japanese yen and improved machinery have recently given Japan an additional advantage.

Foreign Trade. Japanese imports consist of 53 per cent raw materials, 6 per cent foodstuffs, and 40 per

[1] John E. Orchard, *Japan's Economic Position*, p 374, also pp. 339-381. McGraw-Hill Book Company, New York, 1930.

cent semimanufactured and manufactured goods, thus reflecting the raw-material weakness of the Japanese economy. The exports reveal another weakness, namely, that her sales in foreign markets are not well diversified (Fig. 297). Of the exports, 61 per cent are manufactures, 8 per cent are foodstuffs, 31 per cent, most of which is raw silk, are raw materials.

QUESTIONS FOR DISCUSSION

1. Has the economic history of Japan been similar to that of England? of New England?
2. Does Japan have a well-balanced economy?
3. Are there any geographic factors back of the militarism of Japan?

The Regional Geography of Japan

Most of the Japanese people live on small alluvial plains, and each plain is separated from the next by a significant relief feature. Each plain has its own individuality and might be studied as a complete unit. However, in the following section, an attempt has been made to group these hundreds of individual regions into eight regions, although it is realized that this regionalization is not so satisfactory as that in the other regional chapters.[1]

Hokkaido. This hilly island is the pioneer land of Japan. Its New England-like climate is cooler than that of the main island of Honshu and, thus, more solidly built houses, better heating, and more rapidly growing crops are required than in older Japan. Until the last century the island was in the hands of the aborigines, and it has required considerable urging by the government to settle the area. Even today its population density is but one-fifth that of the older parts of Japan.

As in New England, fishing and lumbering were among the first industries and still continue important. Agriculture is limited to the plains and in most of the island oats, beans, barley, and potatoes replace the characteristic subtropical Japanese crops. Animals are of considerable importance and barnyards with horses and cows add an un-Japanese touch to the landscape. In the Ishikari Plain (southwest Hokkaido), rice remains an important crop in spite of the difficulty of growing it in this unfriendly climate. The Japanese Government has tried to teach the people to imitate the food, farming, and housing customs of other cool lands, but the settlers have been very slow to adopt new customs.

[1] The data for this regionalization were obtained mostly from Glenn T. Trewartha, *A Reconnaissance Geography of Japan*, University of Wisconsin Studies in Social Science and History, No. 22 Madison, 1934, and from Orchard, *op. cit.*

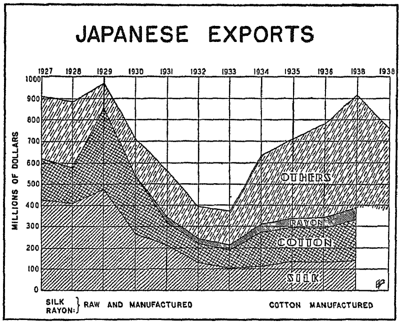


Figure 297. Textiles represent more than half of the Japanese exports.

Manufacturing is of minor importance and is based largely on local raw materials. Paper making, brewing, and fish canning are outstanding, while local coal, iron, and limestone provide for a small iron industry.

Northern Honshu. Here the climate is more moderate, but snow in winter is common, and cold winds from the continent occasionally injure the rice crop. The forests contain maple, birch, chestnut, poplar, and oak and thus differ from the coniferous forests which predominate in Hokkaido and the more luxuriant subtropical forests of southern Japan. Rice is definitely the leading crop, but the cold winters discourage the planting of winter cereals in rotation with rice. Apples and other temperate fruits are common, while tea, sweet potatoes, bamboo, mulberry trees, and other characteristic Japanese plants do not appear except at the southern edge of the region. The population is relatively sparse, partly because the land has only been under Japanese control for several centuries, partly because of the cold winters, and partly because of the lack of extensive plains. Manufacturing centers have hardly developed, although the stimulating climate seems suitable for industrialization.

Kwanto Plains. This alluvial plains area—extending about seventy-five miles to the northeast, north, and northwest of Tokyo—is occupied by about one-sixth of the total population of Japan. Its hot, humid summers and mild winters permit winter and summer crops and some subtropical crops such as tea, peanuts, mandarin oranges, and sweet potatoes. Nevertheless, the Kwanto area is not thoroughly occupied,

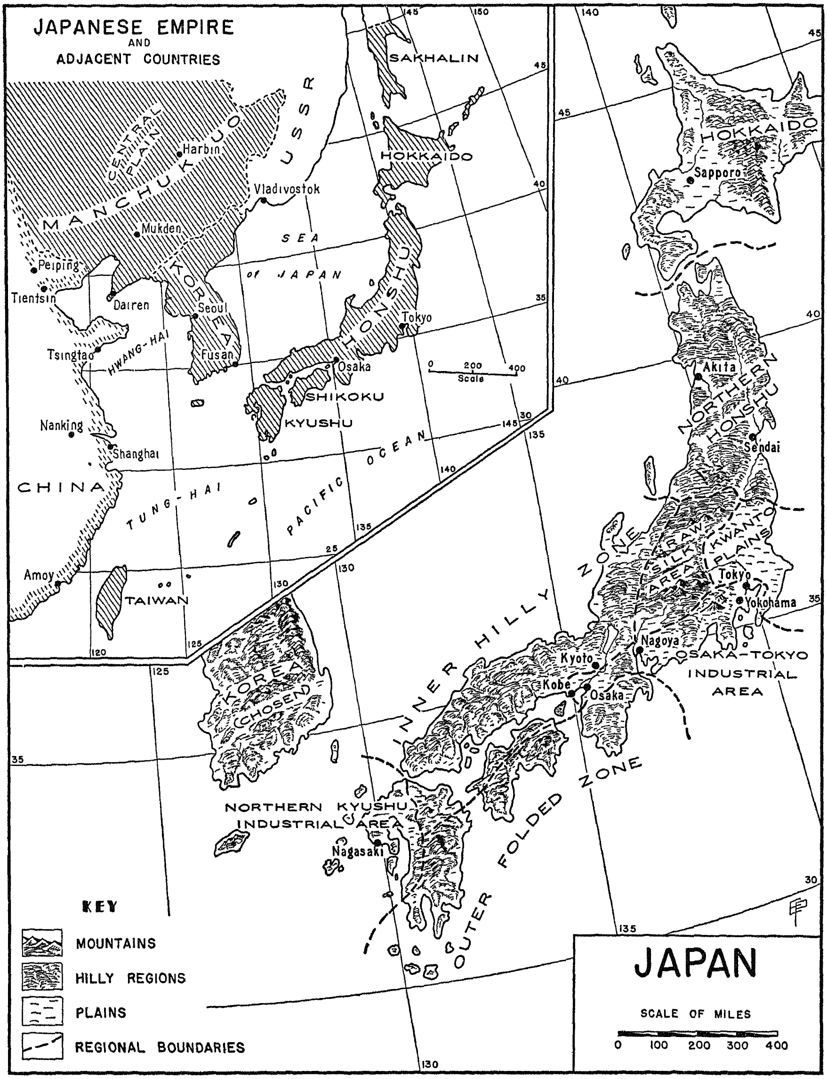

JAPANESE EMPIRE
AND
ADJACENT COUNTRIES
SAKHALIN
MANCHUKUO
CENTRAL PLAIN
U S S R
Harbin
Vladivostok
HOKKAIDO
Mukden
SEA of JAPAN
Peiping
Tientsin
Dairen
KOREA
Seoul
HONSHU
Tokyo
Tsingtao
HWANG-HAI
Fusan
Osaka
SHIKOKU
KYUSHU
Nanking
Shanghai
CHINA
PACIFIC OCEAN
TUNG-HAI
Amoy
TAIWAN
Scale
0 200 400
HOKKAIDO
Sapporo
Akita
NORTHERN HONSHU
Sendai
SILK AREA
KWANTO PLAINS
Tokyo
Yokohama
Nagoya
Kyoto
Kobe
Osaka
OSAKA-TOKYO INDUSTRIAL AREA
INNER HILLY ZONE
KOREA (CHOSEN)
NORTHERN KYUSHU INDUSTRIAL AREA
Nagasaki
OUTER FOLDED ZONE
KEY
MOUNTAINS
HILLY REGIONS
PLAINS
REGIONAL BOUNDARIES
JAPAN
SCALE OF MILES
0 100 200 300 400

Figure 298.

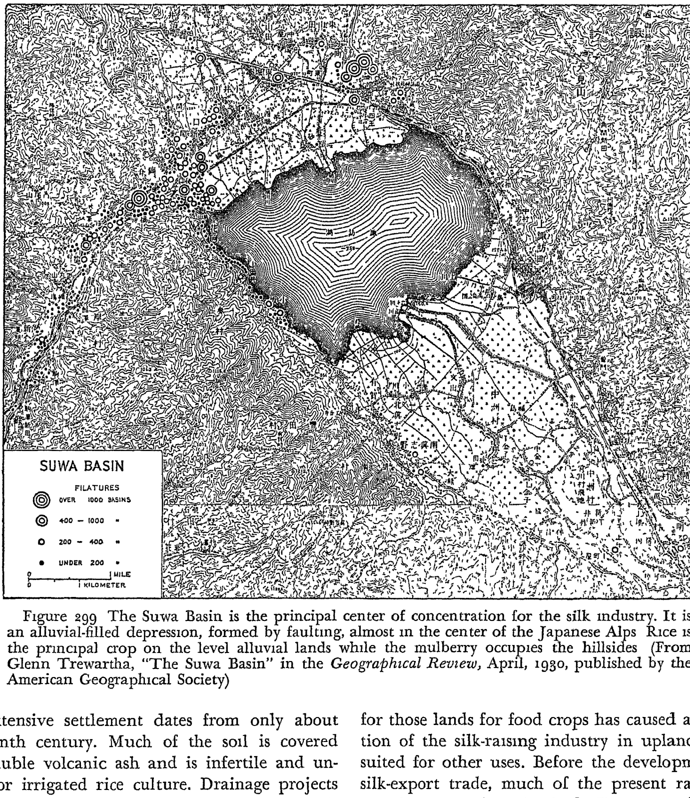


Figure 299 The Suwa Basin is the principal center of concentration for the silk industry. It is an alluvial-filled depression, formed by faulting, almost in the center of the Japanese Alps Rice is the principal crop on the level alluvial lands while the mulberry occupies the hillsides (From Glenn Trewartha, "The Suwa Basin" in the *Geographical Review*, April, 1930, published by the American Geographical Society)

for its extensive settlement dates from only about the sixteenth century. Much of the soil is covered with insoluble volcanic ash and is infertile and unsuitable for irrigated rice culture. Drainage projects have been necessary to make many of the lower lands arable. The uplands are often better suited to mulberry trees, tea bushes, or vegetables than to cereals. Truck farming for the adjacent Tokyo-Yokohama urban district is also important.

The Raw-Silk Area of Central Honshu. The two mountain cores of Japan come together in a mountainous knot in central Honshu. This knot has been further complicated by several great faults which have formed a series of basins across the mountain core. This series of basins—or the Fossa Magna (great ditch)—and the adjacent slopes make up the major raw-silk area of Japan. Formerly, silk was more important in the south, but increasing demand for those lands for food crops has caused a concentration of the silk-raising industry in upland areas unsuited for other uses. Before the development of the silk-export trade, much of the present raw-silk area was but sparsely inhabited. However, silk became such a valuable export product that it is now worth while to transport it even from remote mountain valleys at considerable expense.

The cultivation of mulberry trees represents almost the only phase of Japanese agriculture which is devoted to raising food for animals. The silkworm, which feeds on the leaves, is in fact the most important domesticated animal in Japan. The production of silk cocoons requires a tremendous amount of careful labor, not only in picking the leaves that are fed to the worms, but also in the delicate operation of unreeling the silk from the cocoon, spinning it into threads, and reeling it into skeins of raw silk. The

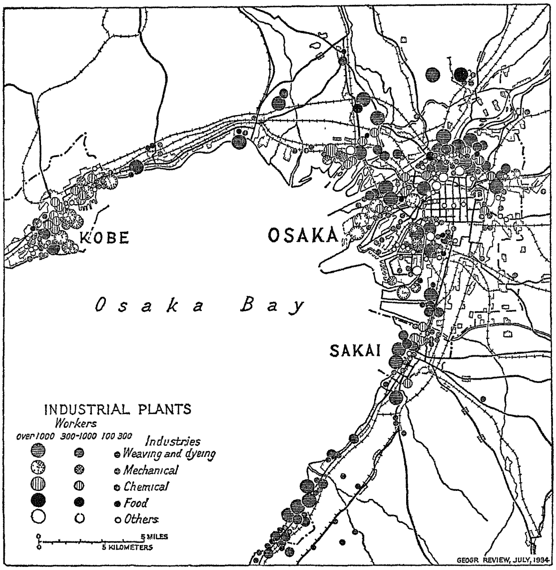


Figure 300. The Osaka industrial area (Courtesy of the *Geographical Review*, published by the American Geographical Society)

industry is most concentrated in the Suwa Basin in central Honshu. Here the mulberry trees are on the slopes where the soil is thin, stony, acid, and little suited for other crops. In some sections the rows of mulberry trees are interplanted with rows of vegetables. As the mulberry leaves are picked constantly, the trees do not shade the other crops The mulberry is a good example of the way in which the Japanese have developed their agriculture so as to use almost every resource of the scarce arable land.

The Tokyo-Osaka Industrial Area. This region is not so continuous as it appears in Fig. 298, but rather consists of a series of industrial centers in and around Tokyo, Nagoya, Osaka, Kobe, and some minor industrial towns on the rail routes connecting these cities. Each of these industrial centers has developed on a plain and has drawn its labor supply from the inhabitants of the plains farms. Silk is readily available from the adjacent raw-silk area, but the bulk of the other raw materials is imported by sea from other parts of Japan or from abroad.

Tokyo has been the political capital of Japan since the end of the sixteenth century. Since so much of Japanese industrialization has been due to governmental encouragement, it is but natural that a considerable part of this development should take place at the political center. Most raw materials had to be imported and Tokyo harbor was unfortunately not deep enough for most ocean-going vessels, hence the port of Yokohama was developed to handle foreign trade. Numerous small factories produce a variety of goods, mostly light in nature. Textiles lead, with printing, bookbinding, electrical machinery, clothing, novelties, and similar industries competing for second place.

Nagoya, like Tokyo, has a poor harbor and must depend on its outport, Yokkaichi, or ship goods via Kobe. Nagoya specializes in textiles with considerable emphasis on silk due to nearness to the raw-silk area. Pottery from local clays is also a major product.

Osaka with its outport, Kobe, is the largest of the Japanese industrial centers as well as the most varied in its products. Through the Inland Sea, it can con-

veniently obtain coal and iron from Kyushu or from Korea and Manchukuo. Its port, Kobe, is visited by all trans-Pacific steamers as well as by countless coasting steamers. Osaka was originally an important commercial city, due to its central position, but, after the Russo-Japanese War, it commenced its rapid growth to an industrial center of 2,000,000 people. The city is on a river delta, intersected by canals which provide cheap transportation for the numerous factories. In addition to all the industries mentioned for Tokyo and Nagoya, Osaka has many of the heavier industries, such as iron and steel, glass making, machinery manufactures, sugar refining, and shipbuilding. Its huge cotton-textile mills have given it the nickname "the Manchester of Japan"

The Inner Hilly Zone of Southern Japan. This region is hilly rather than mountainous. It has been long settled and is intensively utilized. The alluvial plains are small, but numerous, and the arable land is increased by terracing the lower hillsides. The heart of the region is the Inland Sea with its jagged coast, pretty islets, and an uneven shore line bordered by rounded hills. Here is the Japan of tourist travelogues, with well-kept farms, beautiful vistas, and small "artistic" cities. The excellent water transportation has added a modern touch, for small and highly varied manufacturing industries have grown up along the Inland Sea.

Kyoto is the only large city and it might well be included with the adjoining Tokyo-Osaka industrial area. However, Kyoto is the center of historic feudal Japan and its handicraft manufactures are quite different in quality from those of Osaka and Tokyo. This city is twenty-five miles from the open sea, which is a considerable disadvantage in importing bulky raw materials. Hence, it specializes in lacquer work, dyeing, porcelain, cloisonné, and fine textiles. Often its workers add the final artistic touches to goods which have been first manufactured elsewhere.

Outer Folded Zone of Southern Japan. High, rugged, folded mountains isolate this region from the rest of Japan with which it is but poorly connected by coastwise steamers and, in southern Kyushu, by a single railroad. Generally, it is backward. Little of the land is farmed, for level land is scarce and forests dominate the landscape. Copper deposits in the mountains are important, but, except for a few industries based on copper or lumber, manufacturing is undeveloped. The climate is subtropical for the mountain wall protects the lowlands from the cold winter winds from Asia. Hence, palms, cotton, camphor, oranges, and similar plants are added to the usual plant products of central Japan.

Northern Kyushu Industrial Center. Although this area is the one in Japan best supplied with raw materials, it was the last industrial area to develop, probably due to its distance from Tokyo. The Chino-Japanese War (1895) impressed the government with the need for an iron and steel center and government capital was advanced for a large steel plant. In many ways, the region resembles Pittsburgh, for the industrial plants are crowded by the hills into a narrow strip along the water front, local coal is the principal resource, and the smoky atmosphere is quite un-Japanese. As at Pittsburgh, the iron ore is imported, but the Kyushu center has the advantage of being at the junction of the Inland Sea, the China Sea, and the Japan Sea, and so has direct water connection with the iron-supplying areas of China, Korea, and Manchukuo. The industries are predominantly heavy metals, glass, cement, machinery, and shipbuilding, although a few lighter industries—such as ceramics and textiles—have developed as auxiliaries. Located at the gateway of Japan's colonial empire, this region seems destined to play an increasingly important part in the Japanese economy.

QUESTIONS FOR DISCUSSION

1. What areas in other parts of the world are roughly similar to each of the eight regions described above? How do the Japanese regions differ from them in development and environment?
2. The history of the Japanese people seems to illustrate the "Northward Course of Empire." Is this statement true for the period 1880-1937? Explain.
3. What environmental factors have helped to make it easier to "westernize" Japan than to "westernize" China?

The Territorial Expansion of Japan

In addition to industrialization, territorial expansion and emigration were possible outlets for the growing Japanese population. The latter course did little to solve the problem, for the Japanese people were loath to leave the subtropical environment to which most of them were accustomed. Even today, in Korea and Manchukuo, the comparatively few Japanese who are attempting permanent settlement find the climate too severe and competition with the Chinese farmers and workers (who have a much lower standard of living) extremely difficult. The great majority of the Japanese in the lands Nippon has conquered are soldiers, officials, business agents, and other temporary residents rather than a permanent nucleus of Japanese settlers. Emigration to for-

eign countries, with a suitable environment, has been greatly hampered or totally prevented by immigration restrictions.

The main function of Japanese territorial expansion has been to provide markets and raw materials rather than additional homelands. Many observers have queried whether Japan could not attain these ends without military conquest. Even if this be true, Japanese military traditions tend to discourage mere economic expansion. Furthermore, Japan has few illusions about the altruism of European powers, and prefers to consolidate its Asiatic Empire before other powers may decide on further expansion. Another consideration is based on the nationalistic spirit, which has long been strong in Japan, but until recently was almost nonexistent in China. If, however, China should develop a strong national consciousness and then follow Japan in westernization, the greater size and resources of China might make her dominant over Japan and the Far East.

Korea (Chosen). The acquisition of Korea marked the first step in Japanese penetration into the Asiatic mainland. Korea, a true buffer state, has in its history been the "football" of China, Russia, and Japan. All three nations have attempted to exercise control over it, but in 1905 (after the Russo-Japanese War) Japan obtained protective powers over the peninsula and, in 1910, formally annexed the territory. This annexation provided a landing place for Japanese troops and made possible the establishment of military and naval bases from which armies could move for further conquest of mainland areas possessing raw materials and providing markets for Japanese manufactures.

Physical Geography. Korea has often been compared to Italy.[1] Both peninsulas trend from northwest to southeast, both are about six hundred miles in length, but the Italian peninsula is somewhat greater in area. Both have inhospitable eastern coasts, while the ports, cities, most of the rivers and plains are west of the mountain axis. Like the Alps, the wooded Chang Bak San (Long White Mountains) have permitted Korea (like Italy) to preserve its culture which differs from that of the rest of the continent. The capital cities, Seoul (Japanese "Keijo") and Rome, are both centrally located on their respective peninsulas, both are built on hills near a river, and both have marshes to the west and valleys which penetrate the mountains to the east.

However, there are striking contrasts. Korea has more irregular western and southern coasts with many offshore islands. The lowland areas are hilly lands rather than true plains, nor is there any great northern plain analogous to that of the Po. Finally, and probably most important, the Korean climate is radically different from that of the Mediterranean In the north, the climate is humid continental (long-summer phase) with accentuated seasons due to the Asiatic monsoon. In the south, the climate is humid subtropical with much heavier rains than in the northern half and with a maximum in April as compared with June in the north. Temperatures drop below freezing during one month in the south, but freezing weather lasts five months in the north and the Yellow Sea freezes over north of 38° N

Economic Activity. In spite of the broken surface, agriculture supports three quarters of the 20,000,000 inhabitants. The rich soils of the small plains (decomposed lava and alluvial deposits) are supplemented by terracing the hillsides to provide a total of 12,000,000 acres of fertile land. The principal crops raised are rice, barley, wheat, beans, tobacco, cotton, and fruits. The last three crops were introduced by the Japanese Government to stimulate exports and to provide industrial raw materials and additional foodstuffs. The quality of farming is, on the whole, far inferior to that of China and Japan, for the fields are poorly manured and carelessly cultivated. Floods and famines are frequent, and attempts by the Japanese authorities to improve conditions have been hampered by the conservative attitude of the Korean peasant. Domestic animals, especially cattle, ponies, asses, and pigs, are more common than in China and Japan because there is more rugged land on which they can forage. Fish, from the adjacent seas, provide another important element in the food supply.

Japan nearly monopolizes the foreign trade of Korea, for 60 per cent of its imports are Japanese goods and 90 per cent of its exports go to Japan. Korean imports include millet, wheat flour, textiles, sugar, and machinery which are paid for by exports of rice, silk, soybeans, fish, cotton, pig iron, gold, and cattle products

Manchukuo (Manchuria). Japan has had important economic interests in Manchuria (as, for example, the South Manchuria Railway) since the Russo-

[1] The following paragraphs are based largely on the interesting volume of Jules Sion, *Asie des Moussons, Première Partie, Chine-Japon,* Tome IX of the *Géographie Universelle* (in 15 tomes). Libraire Armand Colin, Paris, 1928. This valuable French world geography should be known to all advanced students of economic geography It is especially good for physical description. The four volumes which include material on Asia are the best survey of Asiatic geography available.

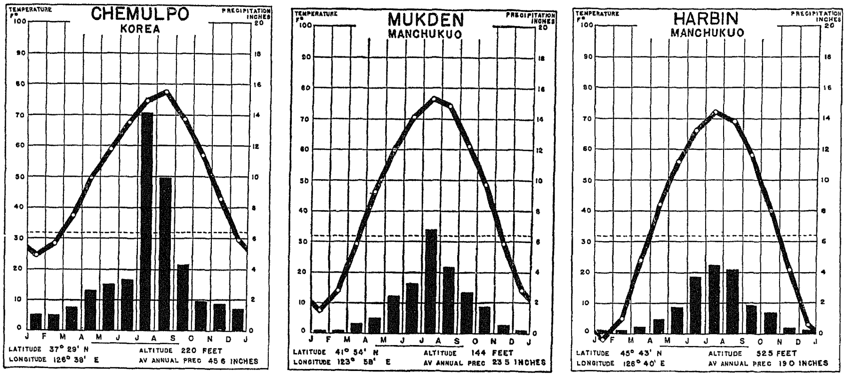


Figure 301. A comparison of these charts with those in Fig 296 indicates why the warmth-loving Japanese have not emigrated to Manchukuo in large numbers.

Japanese War. In 1931, in defiance of the League of Nations, Japan succeeded in placing in power Ching Chang, who became the first Emperor of Manchukuo in 1934. Even though the country is, supposedly, an independent kingdom, behind every key governmental post there is a Japanese adviser whose wishes are enforced by the Japanese Army. Manchukuo is slightly more than three times the size of California and has a population of 34,000,000 people, mostly concentrated in the south and along the railroad lines. Ninety-five per cent of these are Chinese and nearly half have immigrated since the beginning of the present century New transportation provided by Japanese steamers and the South Manchuria Railway, civil wars and famines in China, and the lure of cheap, or free, land have attracted these immigrants. The condition of these immigrants is well described by a Chinese student:

> The migrant farmers on arriving in Manchuria are generally poor with a little belongings consisting of bedding and some clothes wrapped up in bundles which are carried on their backs. They have no cattle, no houses and no agricultural implements . . . Some farmers come with small sums of money but these are not enough to open unreclaimed lands The crop season in Manchuria lasts from April to November, and during this short space of six months the hardy, industrious farmers build in the wild Manchurian Plain a home, and make the wilderness productive of many cereals. . . . When the fields are ploughed, and the seeds are sown, the farmers stay at home for four months to come out again in the autumn to reap the harvest, without taking extra care of the fields such as irrigating the farms or stripping off the weeds. . . . After the harvest season, which comes during the end of October and the beginning of November, the migrant farmers either return to their homes in Shantung or Chihli (provinces in North China) or settle down in Manchuria for some other work The bitter Manchurian winter sets in in November, when a heavy cloak of white snow mantles all the farmyards, and all agricultural activities come to a halt In winter some farmers are hired by timber contractors to fell trees in timber concessions [1]

Climate. The location of Manchuria gives it an almost typical east coast climate, except that the adjacent extensive land mass of Asia makes for greater extremes of temperature. The country tends to be dry, rainfall ranging from less than twenty inches in the northern and central regions around Harbin to twenty-six to twenty-eight inches farther south in the vicinity of Mukden. The country is still within the area controlled by the monsoon so that maximum rainfall comes, fortunately, during the relatively short growing season. Variations in rainfall occur, depending upon the seasonal direction of winds and the topography of specific localities. Climatic conditions in the most important agricultural regions—the central plains of the Amur, Sungari, Nonni, and Lia rivers—are similar to those of the prairie districts of Canada.

Natural Regions. The regional geography of Manchukuo is quite complex, but the country may, in a brief survey, be divided into three natural regions

The Central Plains Region through which runs the Lia River in the south and the Sungari River in the

[1] Tsao Lien-en, "The Method of Chinese Colonization in Manchuria," in *Chinese Economic Journal*, Vol. VII, No. 2 August, 1930, pp. 832-833 Quoted in Isaiah Bowman, *The Pioneer Fringe*, pp. 293 and 294. American Geographical Society, New York, 1931.

northeast, is the agricultural heart of the nation. So important is this area that it is considered to be the largest undeveloped plains area in Asia and the future granary of the Far East. The principal crops are soybeans, wheat, kaoliang, millet, and in the south corn, rice, and cotton. Stock raising is important; cattle are common in the drier areas, horses are raised in the northern half, and pigs are found throughout the crop area. Large amounts of arable land still remain to be put in cultivation, especially in the central and northern plains.

To the southeast is the Eastern Mountain Region which extends from the Sungari Valley to the Liaotung Peninsula. This area has long been cultivated in the southeast, but terracing, tree crops, and the absence of cereals such as wheat and rice indicate that adjustments to rugged relief have been necessary. Both coal and iron ore are also found in the south and are well utilized by the Japanese. The less-settled northern areas contain large tracts of virgin pine, fir, oak, ash, and walnut.

The Western and Northern Region is extremely mountainous, and colder and drier than the area to the east. It is still undeveloped, but contains extensive forest resources which will ultimately be cut to supply Far Eastern countries, especially Japan, with the timber supply that they now lack. The principal trees are oak, birch, elm, fir, and spruce Nomads with their herds of horses, cattle, and sheep occupy the grassland areas in this region.

Minerals. Manchukuo is important to Japan principally because of its coal and iron-ore deposits. Other minerals, as exploration and economic development progress, will increase in importance. Quartzite, dolomite, asbestos, oil shale, and gold are also available in significant quantities. Both the coal and the iron-ore deposits are poor in quality. Relatively little of the 4,000,000,000-ton reserve of coal is good for coking, while the iron-ore deposits range from 20 per cent to 40 per cent iron content, which is much lower than the ores now being mined in the United States.

Transportation and Foreign Trade. Three important railroads serve the country. They are the Chinese Eastern, essentially a branch of the Trans-Siberian, the South Manchuria Railway, and the Chinese Peiping-Mukden line. All are now controlled by the Japanese. The inadequacy of the roads, as in China, definitely hinders economic development, especially during the rainy season when many sections are entirely cut off from markets and sources of supply.

The bulk of Manchukuo's foreign trade is with Japan. More than 40 per cent of the country's exports, including soybeans, millet, kaoliang, coal, timber, and pig iron are sent to Japan; while China is second in importance, receiving about 20 per cent of the exports. The principal imports are cotton cloth, kerosene, sugar, machinery, and tobacco, most of which come from Japan or Japanese possessions.

Sakhalin (in Japanese, "Karafuto"). The southern half of the long, narrow island of Sakhalin has been Japanese territory since the Russo-Japanese War. It is essentially a continuation of the Northern Coniferous Forest of Siberia. Lumbering, offshore fishing (salmon and herring), and mining are the principal occupations and many of the workers visit the island only during the appropriate season for each industry. The mineral resources of the Russian half of the island are far superior to those in the south. Of these, petroleum is being extracted by a Japanese company.

Taiwan (Formosa). Until 1683, Taiwan remained largely in the hands of the aborigines, a head-hunting people who lived principally by hunting and nomadic agriculture. Chinese immigrants forced these primitive people into the high, luxuriantly forested mountains which rise to ten thousand feet to form the western backbone of the island. The typical rice-growing agriculture of southern China became the predominant occupation in the western lowlands. In 1895, Taiwan was annexed by the Japanese who have attempted to make it their major source of supply for subtropical and tropical products. They have been especially successful with sugar cane, and the Japanese Empire is now self-sufficient in sugar. Other lowland products are rice, pineapples, bananas, sweet potatoes, and jute; while tea (Oolong) is raised on hilly land in the north. The camphor trees, which are widely distributed throughout the lower mountain regions, yield the major forest product. Pine and hardwoods are also important.

QUESTIONS FOR DISCUSSION

1. Do the Japanese possessions duplicate Japan in products? in environment?
2. What major raw materials are not obtainable within the Japanese Empire? What is the nearest place where Japan can obtain each of these products?
3. What is the geographic background of Russo-Japanese rivalry in northeastern Asia?

CHAPTER 53

AUSTRALIA AND NEW ZEALAND

ISOLATION is a major influence in the economic and social development of Australia and New Zealand. Both countries are situated antipodal to the British Isles, which is the center of the world's land hemisphere, and thus are approximately in the center of the world's water hemisphere. Although the two countries are physically separated by 1200 miles of water and have different climates and physical structures, this mutual isolation has contributed to the development of similar economic and social systems. The most densely populated sections of Australia are fully 2000 miles from the Dutch East Indies and 4000 miles from the densely populated mainland countries of the Far East. The west coast of the United States lies 7000 miles to the northeast and the Union of South Africa 5000 miles to the west.

There are other similarities which tend to weld both countries together. Both have a higher percentage of white inhabitants than any other country in the Southern Hemisphere. Both are relatively new nations, and agriculture—especially the grazing of cattle and sheep—is their most important economic activity. Until the advent of the modern refrigerated vessel, world markets for a number of their products were almost entirely absent. Because of isolation, the rate of economic expansion and population increase has been very slow, so that neither country has a large number of inhabitants. Furthermore, each has comparatively large areas of unproductive land and is still largely a pioneering country.

Australia

Climate. As isolation has largely determined the main features of the Australian economy, so has rainfall largely influenced the pattern of economic activity within the continent. The distribution of population, the products, and local prosperity are all closely related to the amount and fluctuations of rainfall.

Australia may be thought of as a desert continent, inclosed by a thin shell of humid lands. Within the dry desert interior are few streams, and only where artesian wells are possible is there any security of moisture. To the south of the desert is a strip of land with winter rainfall ranging between ten and thirty inches. To the north of the desert, tropical Australia has a somewhat heavier summer rainfall, but its effectiveness is reduced by high evaporation. The only really moist area in Australia is along the east coast where the mountains of the Great Dividing Range intercept considerable moisture.

The settled areas are near the coast, where temperature extremes are rare. The summers are hot (extremely so in the interior), but the winters are free from extreme cold.

Topography. The continent is divided into three regions, each of which crosses it from north to south. By far the largest is the western plateau which occupies over half the continent. This immense area of old, worn-down rocks is for the most part an immense peneplain. Except where faulting has created a few sharp relief features, it appears level and its changes in elevation occur as gentle rises or depressions. Except on the western edge, streams are almost unknown. For the most part, it is a great desert plain, covered with long lines of sand ridges, occasional scrub, and considerable heath.

The central lowland adjoins the plateau on the east. It is a zone of crustal weakness. Long-continued sinking has been accompanied by the accumulation of great strata of sedimentary rock, which often contain underground water suitable for artesian wells. The climate is dry, but the vegetation is sometimes less sparse than in the interior parts of the western plateau. Streams, of an intermittent nature, are fairly common.

The eastern highlands form a continuous chain from Cape York to Tasmania. Only in the southeast are they high enough to be a serious barrier to transportation—in fact they have been described as a series of plateaus rather than steep mountain ridges. They are, however, of great importance, for they have in-

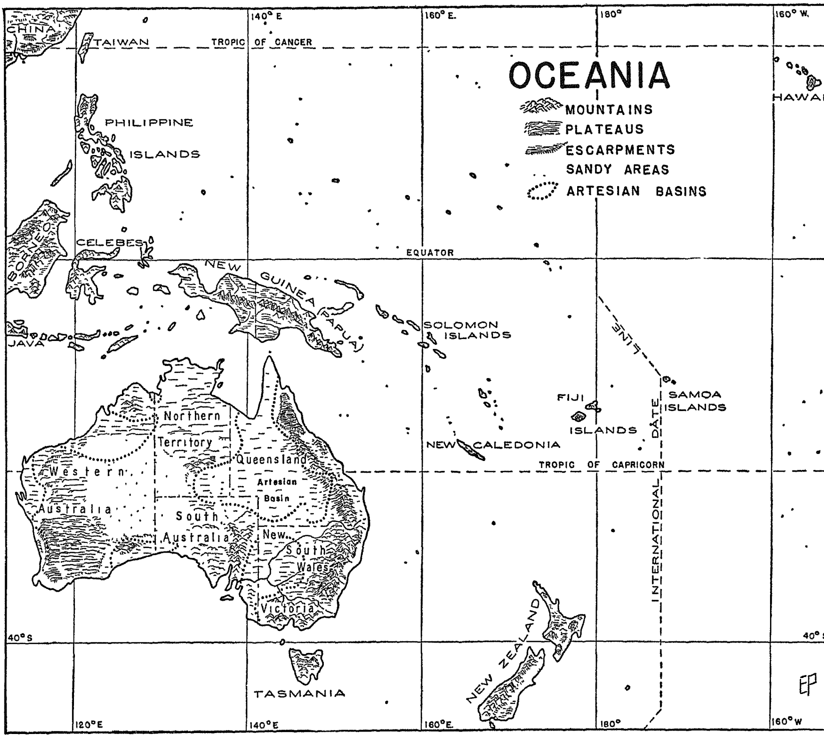


Figure 302. Physiographic diagram of Oceania. Why is there no scale on this map?

creased the rainfall of eastern Australia, are the source of the Murray—the only large Australian river—and contain numerous minerals. Their greatest disadvantage is that they have limited the amount of level land in what is, climatically, the best part of Australia.

Minerals. For a country that has so much useless land, the importance of minerals to Australia cannot be overemphasized. As in California, the gold rush to Australia during the nineteenth century did much to expand population and settlement. The deposits were first found in western Australia and later in the eastern highlands and Tasmania. Gold mining has declined considerably, however, and coal, silver, and lead now outrank it in importance. Other minerals include iron, copper, zinc, tin, chromium, manganese, and phosphates. Petroleum has not been discovered in important quantities.

Population. Several outstanding characteristics of the Australian population deserve mention. Nearly half of the 7,000,000 people reside in the cities, which is remarkable in a country which is largely agricultural. This has been attributed to the large numbers of retired farmers and miners, to the concentration of manufacturing and commerce in a few large centers, and to a large transient population which engages in seasonal labor (as sheep shearing) in the rural districts. The rate of population increase during the past generation has been more rapid than in many other new countries—including Canada, United States,

and New Zealand—and is due largely to immigration. No large centers of population, except a few mining towns, are more than one hundred miles inland. More than 98 per cent of the population is white, and of these 97 per cent are of British ancestry. Ninety-eight per cent of the inhabitants are literate. The people are more unilingual than in any other country, only one thousand commonly speaking a language other than English.

Australia has been known almost since its settlement as a white man's country, and it is from this circumstance that many of Australia's present-day problems evolve. The policy of the Australian Government is rigidly to control immigration so that "undesirables" can be excluded, and as a result practically no people of non-British extraction have been admitted into the country. Many economists believe that, ultimately, such a policy will result in economic ruin for the country because of the high wage scales it entails and resulting high costs of production. Others contend, also, that in a land so limited in agricultural resources, valuable tropical development will be impossible with white labor alone and this policy will, therefore, restrict complete economic expansion. Many Australians, on the other hand, maintain that the northern tropical lands can be settled by the white man with superior health qualities. They point with pride to the fact that, in northern Queensland, a community of more than 200,000 whites is surviving through two or three generations in conditions which are generally considered too tropical for whites.

Australia is essentially a pioneer country and greatly limited in its potentialities. Despite its vast area, of nearly 3,000,000 square miles, fully 50 per cent of it will probably never be settled. Griffith Taylor[1] divides this subcontinent into twenty-two settlement areas that can be combined in the following manner:

1. Wet regions. These are the southeast coastal region and southwestern tip which are closely settled.
2. Favorable subarid regions. Here pioneering can be carried on without the aid of large government subsidies. Individuals can develop these regions.
3. Subarid regions. Similar to 2, but large-scale enterprise is needed for pioneering in these areas.
4. Arid regions. These are unsuited to pioneering by anyone, regardless of size of project or funds involved.
5. Hot, humid coasts. These cannot be economically developed by the white man.

On the basis of this classification the population of Australia, at the present high standard of living, cannot, economically, exceed the carrying power of the land of the wet and subarid regions. It has been estimated on this basis that Australia's population will never exceed 15,000,000 and that an increase to this number would depend upon a greater intensification of agriculture, industrial and commercial expansion, and increased immigration.

[1] Griffith Taylor, "The Pioneer Belts of Australia," in *Pioneer Settlement*. American Geographical Society, New York, 1932.

Agriculture and Pastoral Industries. Although agriculture and the animal industries employ but 22.9 per cent of the gainfully employed workers in the country (as compared with 31 2 per cent for manufacturing and building), they are the backbone of Australian economy. They furnish nearly all of the exports upon which the country is so largely dependent and most of the freight for the railroads and shipping, are the source of most of the products handled by the commercial community, and furnish the income—directly or indirectly—for the customers of almost every other activity. The actual percentage of the country's total workers engaged in these industries has declined steadily for several decades. This, however, represents an increase in the application of machinery to grain production and greater efficiency per worker rather than a decline in the basic value of the industry.

Sheep dominate the pastoral industries of Australia. They are well suited to the large areas of dry land, the sparse population, and the production of products (especially wool and frozen mutton) which can be exported to far-distant markets. Australia has reversed the usual rule and raised beef cattle largely on land that was unsuited to sheep. This has been due to the fact that sheep products, especially wool, stood the long journey to market better than beef products and to the scarcity of good fattening lands where range cattle may be put in final condition for the market. The land suitable for the growth of corn and juicy grasses is so scarce as to be required very largely for the production of direct human food or the raising of dairy cattle. In very recent years, experiments with the export of chilled rather than frozen beef have been successful and have resulted in higher prices in the English market, thus giving more encouragement to the beef-cattle industry.

Wheat, raised either for grain or for green forage, occupies 71 per cent of the crop land of the country, a condition which would almost justify calling Australia a "one-crop" nation. Wheat is also suited to the semiaridity of much of the country, the large areas of flat or rolling land, and the isolation from markets. All of the other crops which occupy any considerable areas of land are also grasses or grains

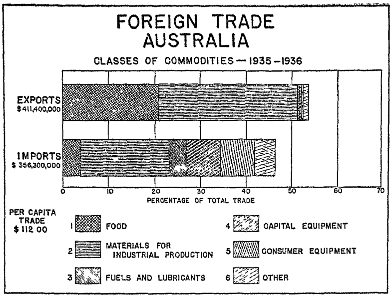


Figure 303

Hay occupies 13.7 per cent, oats, 6.12 per cent; barley, 2.07 per cent, and corn (maize), 1.35 per cent Sugar cane, with 1 46 per cent, and orchards, with 1.26 per cent, are the only other crops which occupy more than one per cent of the cultivated land.

Manufacturing. Modern industry in Australia is expanding, but largely under a system of government subsidy or protection. In 1901, 194,000 of the 3,765,000 inhabitants were industrial workers; whereas, in 1936, the number of industrial workers had increased to 492,000 of that year's population of 6,866,000. The number of factories in Australia also increased in number from 11,550 in 1903 to 24,894 in 1936. The increase in factories, however, was in small plants

The leading manufacturing industries are clothing and other textiles, metals and metal products (including machinery), foods and beverages, paper and printing, vehicles, woodworking, stone, clay, glass, and boots and shoes.

The basis of manufacturing is local raw materials and a protected home market. In recent years, manufacturing costs have shown a definite tendency to increase and protective tariffs have been introduced in the hope of inducing foreign firms to set up branch plants in Australia. However, high wages paid to workers, minimum wage laws, and old-age pensions have resulted in high costs of production and high prices.

Trade. A large part of the trade of Australia is with foreign countries. Internal trade is discouraged by the similarity of regional products, costly overland transport, and by the better quality of many foreign goods. The union of the six Australian states into the Commonwealth of Australia (1901) abolished interstate tariffs and greatly encouraged internal trade. Since that time, a government policy of tariff protection (often supplemented by embargoes) has given a further impetus to Australian industries. The desire for self-sufficiency has been greatly increased by the World War and more especially by the declining demand for Australian agricultural products in some foreign markets since the war.

The exports are few in number and are exclusively foodstuffs and raw materials Sheep products (wool, sheepskins, and mutton) are by far the most important and make up nearly half of the exports in value. Wheat and flour make up one-quarter of the exports, while the remaining important exports—butter, beef, fruit, wine, lead, and cane sugar—are much less important. Nearly half of the exports go to the United Kingdom. Japan has recently drawn largely on Australian raw materials and has taken as much as one-seventh of Australia's exports.

The imports are much more varied in nature and origin They are almost entirely manufactured goods and are received from all the leading industrial countries. The United Kingdom has the lion's share (43 per cent) and the United States is second (15 per cent).

QUESTIONS FOR DISCUSSION

1. Rainfall in Australia is obtained from
   a. cyclonic storms which cross southern Australia from west to east
   b. storms which come from the northeast
   c. the Australian monsoon

   How do these facts help to explain the seasonal and regional distribution of Australian rainfall? Where else are similar phenomena found?
2. Compare Australia and the United States as to size, latitude, resources, products, and economic development.
3. What effects might the abandonment of the present policy of "white Australia" have on her economic and social system?

The Regional Geography of Australia

Many of the Australian regions are, physically, similar to equivalent regions in the United States, but often differ greatly from the American regions in their utilization. For example, the Mediterranean area which makes up such a large part of arable Australia, specializes in wheat and sheep. The equivalent American area in southern California devotes but a small part of its land to these products. Again, Australia has an area with humid subtropical climate, but there is no important Australian cotton belt, for there is no supply of cheap, colored labor.

Cool Southeastern Australia and Tasmania. This region roughly resembles the Pacific Northwest of the United States in size, topography, climate, and popu

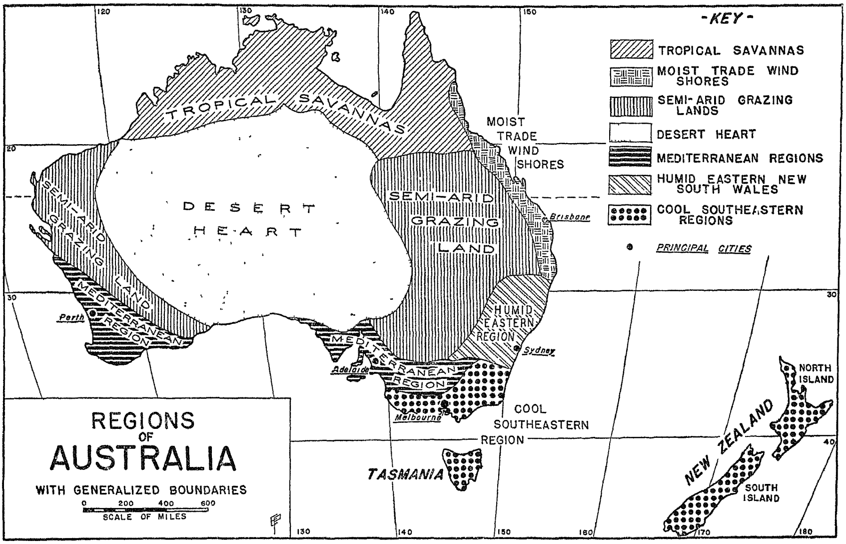


Figure 304.

lation. There are, however, many significant differences. The latitude of the Australian region is lower, and average temperatures are somewhat warmer. Fishing and lumbering, which are the economic backbone of the Pacific Northwest, are of subordinate importance in the comparable Southern Hemisphere area. While the Pacific Northwest is peripheral to the American economy, the region around Melbourne is the best-developed part of Australia.

Like the Pacific Northwest, this region has well-developed lowlands which contrast sharply with near-by, almost uninhabited mountains. However, the products of the lowlands reflect the demand for Australian goods in the United Kingdom. Sheep, of the dual-purpose type, contribute huge quantities of wool, frozen mutton, and sheepskins to the export trade. In the moister areas (east of Melbourne and in Tasmania), dairy cattle produce an important butter and cheese export. Apples, pears, berries, and other cool-temperate fruits are common and are exported—fresh, canned, dried, and as jam. Other farm products, primarily for local consumption, include potatoes, oats, barley, wheat, and hay.

The rugged areas within the region are highly mineralized. These minerals attracted settlers long before it was profitable to export agricultural products They have declined in importance, but coal and gold are still important in Victoria and copper, tin, lead, zinc, and silver are important products in Tasmania.

Melbourne, a rapidly growing city of 1,000,000 people, is located on a deep indentation of the southernmost coast of Australia. It is the port for most of the state of Victoria, and is also a political and industrial center. Many of its industries, such as flour milling, canning, and meat freezing, are connected with the export trade. It also manufactures many lighter articles—including leather, woodwork, books, textiles, and clothing—for the Australian market. Heavier industries are discouraged, because the high-grade coal fields are nearer to the Sydney-Newcastle industrial center, but the development of hydroelectric power in the Victorian mountains is partially overcoming this handicap for Melbourne.

Humid Eastern New South Wales. In latitude and humidity this area resembles the South of the United States, but the moderating influences of altitude and adjacent water reduce the summer tempera

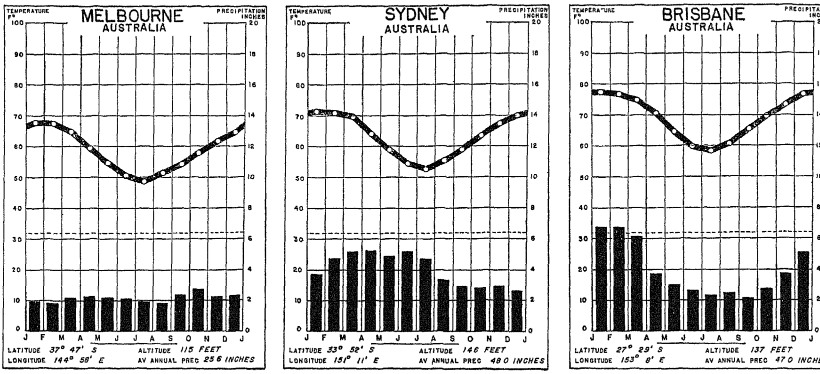


Figure 305. These three charts show the climates in the most humid and most populous parts of Australia.

tures to about those of the Corn Belt. The winters, however, are mild, and palms are not uncommon along the coastal lowlands. The agricultural products are distributed in successive strips which roughly parallel the coast and whose boundaries are determined principally by changes in rainfall and relief. The coastal lowlands specialize in corn, hay, fruits, vegetables, and oats. These crops, combined with dairying, form a highly diversified system of farming. Back of the narrow lowland strip (ten to forty miles in width) are the high rugged plateaus which are often uninhabited and, perhaps, are largely uninhabitable. The better parts of the plateaus raise wheat, oats, sheep, and dairy cattle. On the western slopes of the plateaus the land is gently rolling, the soil fertile, and the rainfall abundant and fairly reliable. Altogether, this is one of the best agricultural parts of Australia. Sheep raising is the major industry, beef cattle are of considerable importance, while winter wheat is the outstanding crop. Some oats and alfalfa are raised as fodder crops.

The widest part of the coastal lowland (around Sydney and Newcastle) has become the leading industrial, commercial, and financial center of the Australian Commonwealth. Sydney, a city slightly larger than Melbourne, owes its development to its excellent harbor—one of the best in the world. In earlier times, it was handicapped by lack of overland communication with the interior, for rugged plateaus inclose the coastal lowland on three sides. This barrier has been overcome by several trunk-line railways which connect Sydney with Melbourne, Adelaide, and the interior plains. Much of the freight for the other Australian ports is sent by coastal steamers rather than across the plateau.

As an industrial center, this area can utilize the large iron-ore deposits in the plateau west of Sydney, the high-grade coal around the port of Newcastle, and an excellent supply of Australian agricultural raw materials Almost every branch of industry is represented here, including an important iron and steel industry. In spite of this industrial development, the export trade of the ports is largely in raw materials The factories of the coastal area employ about 120,000 people out of a total population of 1,800,000, but many of these workers are merely processing raw materials.

Mediterranean Australia. A strip varying in width from fifty to two hundred miles and bisected by the Great Australian Bight, extends almost across southern Australia Unlike other large regions of Mediterranean climate, most of its land is extremely level and the few exceptions are hilly, rather than mountainous, areas. Such a land is almost ideal for the cultivation of winter wheat by machine methods Wheat is, therefore, much more important than in other Mediterranean regions, and it is the tremendous harvests of wheat in this area which make it the outstanding Australian crop. The other major crop is fruit—especially wine grapes, although oranges, currants, peaches, olives, and other subtropical fruits are fairly common The most intensive fruit-raising areas are near the Murray River and depend on its tributaries for irrigation water. Sheep and cattle are wide-

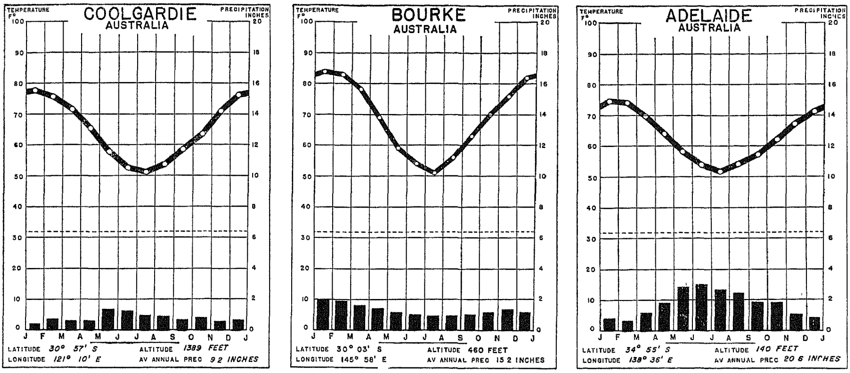


Figure 306 Most of Australia is arid or semiarid

spread throughout the Mediterranean region, although they are by no means as concentrated as in the more humid eastern region. As might be expected from the semiarid conditions, the sheep are of the Merino type and the cattle (except for dairy areas around the few cities) are beef or range cattle. There are almost no other industries, except such commercial and industrial activities as are subordinate to and dependent upon agriculture. The single exception is the lumber industry in the humid tip of extreme southwestern Australia. The woods exported are karri and jarrah—two varieties of eucalyptus—which have a world-wide reputation for use as wood blocks and piles.

The Semiarid Grazing Lands. Surrounding the barren heart of Australia is almost a complete ring of lands which, although they do not have so many sheep and cattle as the surrounding, more humid areas, nevertheless are used almost exclusively by the pastoral industries. They might be compared to the range country of the American West, but they lack its cold winters and their rainfall is even more uncertain. They have other handicaps, such as cattle ticks, wild dogs, prickly pears, and—above all—rabbits.

The history of the Australian rabbit pest is an interesting example of the dangers of introducing an exotic element into an environment. Certain diseases and natural enemies, which keep down the rabbit in Europe and America, are not present in Australia. In 1863 there was a single rabbit warren in Australia. A fire burned it down and the rabbits escaped and multiplied. By 1888 the Australian state of New South Wales had spent more than $5,000,000 in combating the rabbit pest Today, rabbits cost the Australian Government many millions each year, which are spent for poisons, traps, and rabbit-proof fences. Since ten rabbits eat as much herbage as one sheep, the damage done by the countless millions of rabbits can be imagined. But a partial compensation is the large export of frozen rabbit meat and rabbitskins. The fur of the latter is used for making felt hats, and for this purpose the United States imports more than 5,000,000 Australian rabbitskins annually.

Drought is another handicap of the region. Griffith Taylor[1] mentions as drought years since 1880: 1881, 1884, 1885, 1888, 1895, 1896, 1897, 1899, 1902, 1907, 1911, 1914, 1919, 1923, and 1926. These droughts have, at times, nearly wiped out the animal industries over large areas Since 1885, the damage from droughts has been reduced by drilling artesian wells. This is only possible over the Great Artesian Basin which, fortunately, occupies most of the central lowlands—including most of semiarid Queensland, adjacent New South Wales, and South Australia.

Within the grazing lands are several important mineral areas. The Broken Hill silver, lead, and zinc mines in northwestern New South Wales have been productive for many decades and are only now declining slightly in production. The copper, zinc, lead, and gold mines of central Queensland are of growing importance. These mines have been a boon to the pastoral industries, for they have caused railways to

[1] "Agricultural Regions of Australia," in *Economic Geography* April and July, 1930, p. 236.

be built in pastoral sections which otherwise could not support them.

The Desert Heart. This is one of the most barren regions in the world. Much of it is totally uninhabited, even by the aborigines. The best areas are occupied by a few officials, missionaries, and several thousand Australian blacks and half-breeds A railroad has been built by the government to Stuart (Alice Springs) in almost the center of Australia, but its fortnightly train carries little freight and few passengers. From Stuart, the Overland Telegraph Line continues across the desert to the northern coast, where it connects with cables to India and Europe A railway has been proposed to parallel the telegraph line, but there seems to be no good reason why passengers should choose this hot, uninteresting, overland journey for the sake of shortening, slightly, their ocean voyage to Europe.

The Moist Trade-wind Shores. The eastern coast of Queensland is the site of an interesting experiment in acclimatization. This is the one large section of tropical Australia which has rainfall reliable enough and alluvial soil fertile enough to insure successful agriculture. The "white-Australia" policy has determined that the plantation owners and laborers alike should be white, and the former Melanesian colored laborers have been excluded since the beginning of the century. The sugar industry has been successful, but only because the government has subsidized it heavily by placing an embargo on foreign sugar and forcing Australian consumers to make up the losses suffered in dumping the surplus abroad. Other products include corn, tropical fruits, and cotton. If cotton production could be mechanized, some of the drier parts of this coast would be ideal for this crop. Expensive labor, however, has restricted the acreage, and the Australian people have not been willing to protect cotton as they have sugar.

The Tropical Savanna. Northern Australia is almost as empty a land as the desert heart. Most of the land is still in the hands of the blacks. The cattle industry is the only white man's industry, and even this industry depends on government help and the labor of the despised aborigines. Dr. Price of the University of Adelaide indicated the hopeless nature of the country in the following words:

> In 1843 Crawfurd of Singapore stated that, owing to the uncertainty of the monsoon and the seasonal rainfall, he could not conceive of a tropical region more unfavorable. In the seventies, eighties and nineties the South Australians introduced Chinese labor and attempted to establish sugar, rubber, coffee and cinchona on soils that were considered "rich enough to use as guano" All efforts were unsuccessful. In the words of one disgusted settler, "a more barren country God had never made." It was "doubtful if God had made it at all." The "White Australia" policy defeated attempts to bring in Tamil labor South Australian offers to pay the passage of agriculturists were sensibly rejected by the Japanese The commonwealth spent large sums on experimental farms and small white blockers With a few exceptions, such as Vriborg, a Swede, who uses aboriginal labor on the Adelaide River, these have all failed.[1]

QUESTIONS FOR DISCUSSION

1. Compare the regional development of Australia with that of South America and South Africa in the same latitudes
2. Look up the trade of Australia with the United States in the *Foreign Commerce Yearbook* Explain the important items. Does the trade of Australia with the United Kingdom resemble that of the United States with the United Kingdom?
3. Which region in Australia is likely to increase its population most in the future? Why?

New Zealand

Like Australia, New Zealand is an isolated, pioneer country with a progressive, white population It is also essentially agricultural and closely resembles Australia in the nature and direction of its trade. However, New Zealand resembles the best parts of Australia and, therefore, is free from certain characteristic Australian problems such as drought.

Relief. Topographically, New Zealand contains considerable variety in its slightly less than 100,000 square miles. The southern and larger island has a high mountain backbone near its northwestern coast and is famed for its majestic scenery. Many of the mountains reach to the sea, but often they are intersected by rich fertile valleys. The only large plains are found on the eastern and drier slopes. The northern island is less rugged. Its mountains are more centrally located and almost surrounded by plains. It contains the many geysers and hot springs for which New Zealand is noted.

Climate. New Zealand is roughly similar to Great Britain in climate, except that, being nearer the lower latitudes, it is generally warmer. The islands are one thousand miles long from north to south, so that a variety of climates, with a corresponding variety in agricultural products, is present. Their climate is almost entirely controlled by the prevailing westerly winds which bring cyclonic rainfall to the west coast. The insular nature, however, modifies temperatures, and narrowness permits leeward areas to receive sufficient moisture for agriculture. The rainfall is great-

[1] A. Grenfell Price, "Pioneer Reactions to a Poor Tropical Environment, a Journey through Central and North Australia in 1932," in the *Geographical Review*, July, 1933, pp 365-366.

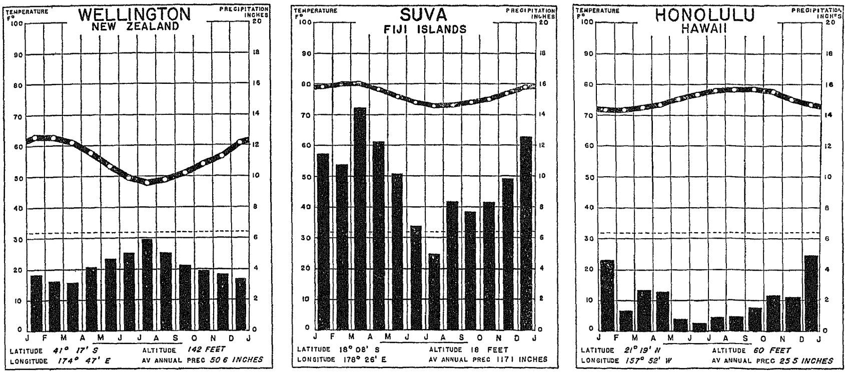


Figure 307. Mild climates such as these are characteristic of islands

est along the west coast (forty-five to one hundred inches), but drops to twenty-five to sixty inches in the east. There is no dry season, but, as in most marine-west-coast areas, the heaviest rain is in winter.

Agriculture. The greatest natural resource of the islands is the fertile land. No deserts exist, as in Australia, but the west-coast mountain ranges make one-sixth of New Zealand unproductive. Because of the cool summers, mild winters, and adequate rainfall, pasture and grazing lands are abundant. Where natural grass coverage does not exist, fodder crops such as hay, oats, barley, and clover can usually be raised. Wheat, corn, peas, and beans are also important crops. The most important grain district is on the east side of the South Island, but only sufficient wheat and other cereals for the home market are raised.

Nearly four-fifths of the area is devoted to pasturing sheep and cattle. In the early history of the country, only wool-bearing sheep were raised, but with the advent of modern means of transportation mutton breeds were introduced, so that today New Zealand exports more mutton than any other country in the world. Sheep pasturing is concentrated more on the east side of the islands and to the south of North Island than elsewhere. These areas are the drier, more hilly sections of New Zealand Dairying and cattle raising are most important on the more level areas, the better pasture being devoted to the dairy industry.

Natural Resources. The first colonists in New Zealand found the islands covered with a dense evergreen forest of pine, beeches, and (in the north) palms. Much of this was destroyed either by lumbermen or to clear the land. Much land suitable only for forest was cleared—hence New Zealand, less than one century after its colonization, is now undertaking a reforestation program. Some 23,000,000 trees have been planted by the government, including many imported European species. The humid climate and the large proportion of rugged land should make New Zealand a lumber exporter in the future.

The mountains of New Zealand seem to be highly mineralized, but the mineral production is not large. Coal is mined for local consumption and iron ore is available for local industry. Gold, silver, and tungsten have been exported in small quantities. Water power, now controlled by the government, is an important potential resource, and no country of similar size has so great a water-power reserve.

Manufacturing. One-tenth of New Zealand's workers are classified as "industrial," but many of these are engaged in preparing meat, wool, and dairy products for export. Since 1908, small factories have developed to supply the limited local market with woolens, furniture, glass, and metal products.

As in Australia, manufacturing costs tend to be high, due to the high standards of living of the workers and the prevailing high wage schedules. The basis for continued expansion of the country's manufacturing industries lies in the available local raw materials, the increasing size of the market, and the presence of cheap water power. At present, the local market is limited so that large-scale, mass production

is not possible in most of the manufacturing industries.

Trade and Commerce. More than 90 per cent of New Zealand's exports are products of its pastoral industries. The most important products are wool, meat, butter, cheese, hides, and skins. The United Kingdom receives nearly four-fifths of the country's exports.

The import trade of New Zealand is similar to that of Australia. Ninety per cent of the imports are manufactured goods, of which about half comes from the United Kingdom and about one-eighth from the United States.

Oceania

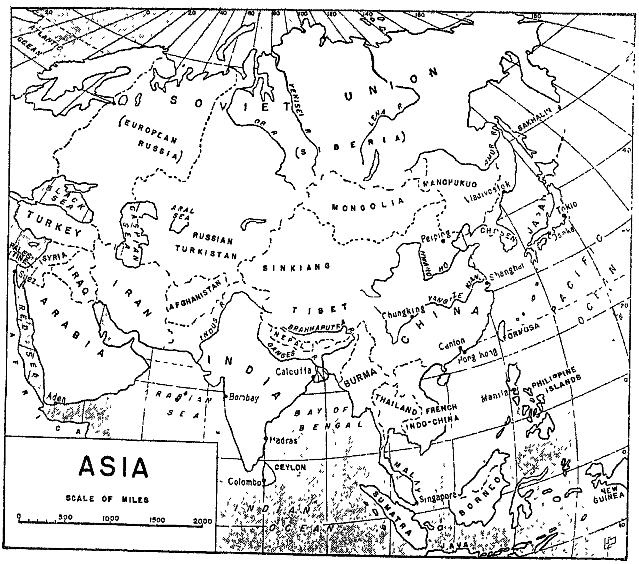
Countless coral and volcanic islands, most of them very small, make up Oceania. At the time of their discovery, the aboriginal inhabitants (mostly Polynesians) were skilled in many arts and had a well-developed society. In almost every case these people have degenerated under the influence of European domination. Today, with a few exceptions, such as the Hawaiian and Fiji groups, these islands produce little for trade except a few coconuts. Where other crops have been introduced on plantations, the labor has usually been imported.

Fiji Islands. This large group of 250 islands (7050 square miles in area) consists of the summits of extinct volcanoes. The rich soil and humid climate are well suited to plantation agriculture. To provide an adequate labor supply, Indian coolies were brought in and they now almost equal the natives in number. The products are coconuts, sugar, bananas, and rice

Hawaiian Islands. These islands are roughly similar to the Fijis in size, structure, soil, and climate. The population includes Polynesians, Chinese, Japanese, Americans, Filipinos, and others. The Oriental groups have provided the labor needed for the scientifically operated plantations Complicated systems of irrigation and fertilization have made the sugar and pineapple plantations among the most productive in the world

QUESTIONS FOR DISCUSSION

1. To what extent does position account for the development of Hawaiian plantations?
2. Compare New Zealand with the Pacific Northwest of the United States.
3. Do you think New Zealand or Australia will ever become as industrialized as the United States? Why?



CHAPTER 54

AFRICA, SOUTH OF THE SAHARA

It is hard for most people to realize that this continent which is adjacent to Asia and Europe and which, through Egypt, contributed to the greatness of the Mediterranean civilization before the dawn of history has been but recently known in most of its parts. The grandfathers of this generation of students saw "the map unrolled" by Gordon, Livingstone, Stanley, and a host of others. It was not until 1900 that any man had ever traveled overland from the Cape of Good Hope to the Mediterranean.

Now, most of Africa is owned or controlled by European nations, but the process of partition has taken place largely in one lifetime. Even today, Africa is a relatively undeveloped continent. It contains many unexploited areas well suited for development by whites and, possibly, for white colonization. But at present Africa contributes only 4 per cent of the total world trade, and most of this is concentrated north of the Sahara and in the southern tip of the continent.

Africa has great present and potential wealth in its soil, plants, minerals, animals, and labor. Why, then, were its resources so long overlooked by European exploiters? This apparent neglect was due in part to topographic isolation, for much of the wealth is on a high plateau, separated from the coast by desert, or fever-ridden swamps. A further explanation lies in the attraction of more obvious wealth in Asia and America. This has been well expressed by Bowman:

> Africa itself was then of less commercial interest than the Orient. Algoa (to Goa [1]) and Delagoa (from Goa) register this state of obsession with what lay beyond Africa. The rival nations were content with mere footholds that served as way stations for ship repair and revictualing. The British had St. Helena, and later a part of the Gold Coast, the Dutch, Table Bay (Cape Town); and the Portuguese, Zanzibar. In fact, down to the period of the exploring expeditions and missionary journeys of Livingstone (1840-1873), Africa had not been penetrated at all effectively, as the maps of sixty years ago clearly show, and as a colonizing field it was thought expensive, unhealthful and of little value.[2]

The Environment

Shape and Position. Africa's position is such that most of its fertile lands are separated from Eurasia by the wide expanse of the world's largest trade-wind desert, the Sahara. Even when the Cape of Good Hope route to India was universally used, the shape of Africa discouraged sailing vessels from touching its coasts except near the southern tip. Usually these vessels followed the African coast to Cape Verde and then did not sight the coast again until near the Cape of Good Hope. Even today this route is followed by many boats bound for South Africa and Australia. Africa's shape has the additional handicap of being most narrow in the most favorable latitudes for development by the white people.

Topography. Eurasia and the Americas are characterized by skeletons of folded mountains, but, in sharp contrast, the framework of Africa consists of great plateaus. Except for folded ranges in the extreme north and south, the mountains of Africa are volcanic peaks, fault-block mountains, or escarpments at the edges of the plateaus.

This plateau structure—highest in the east and gen-

[1] Goa is a seaport in a small Portuguese colony on the west coast of India. It was at one time a leading port in Indo-European trade. Algoa and Delagoa are in southern Africa.

[2] Isaiah Bowman, *The New World*, 4th ed, p. 637. World Book Company, Yonkers-on-Hudson, 1928.

ANALYSIS OF PLATE XXV: TROPICAL AFRICA

XXV A Tropical rainforest clothes the stream valley, while scrub covers the hillsides Note the steep slopes cultivated on the left.

XXV B Lax methods and low yields characterize this native cotton culture in typical savanna conditions.

XXV C. These nomadic Masai are clothed largely in leather from their animals Note the humped cattle (zebu) in the background

XXV D. Note how the brush encroaches on the trail ready to wipe it out if not kept under constant control.

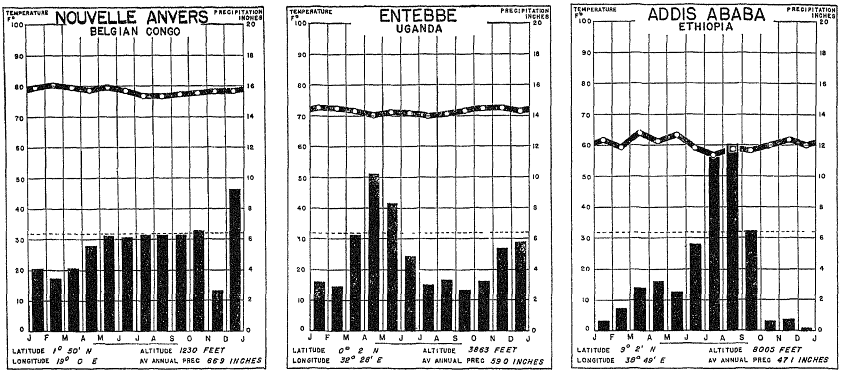


Figure 308. Altitude moderates the temperatures in a large part of tropical Africa.

erally sloping to the west and northwest—has had manifold consequences. It has caused the development of a very regular coast line and has formed a sharp barrier of cliffs back of this coast line, which has hindered the penetration of the interior. The rivers, in their courses from the plateaus to the sea, cross these escarpments in a series of rapids or falls—a fact which is favorable for water power but a tremendous handicap to river navigation. The plateau surface is often flat or rolling, and is often high enough to make the climate subtropical or temperate, even on the equator. This makes for easy development once the less healthy, and often more rugged, coastal areas have been crossed.

Climate and Vegetation. The vegetation of Africa is closely controlled by the climatic regions and both are noted for the regularity of their distribution north and south of the equator. Thus, the Mediterranean climate and vegetation of Morocco, Algeria, and Tunisia are reproduced in a small area in the same latitudes in the Union of South Africa. The Sahara has its Southern Hemisphere equivalent in the Kalahari, and so forth.

One noteworthy feature of African vegetation is the relatively small area in dense forest. Scrub forest and grasslands are characteristic. This results from the division of the year into wet and dry seasons throughout most of the continent (Figs. 308 and 311). Only in the Congo Basin and along parts of the West African coast are there extensive forested areas. The great expanse of grasslands suggests tremendous possibilities for the expansion of pastoral industries as well as for crops such as cotton, peanuts, and millet.

The bad reputation of Africa's climate is due largely to the experience of traders with damp coastal lowlands. Much of the plateau has climatic conditions which are no worse than those of southern United States. (Compare the charts in Fig. 308 with those in Fig. 240, p 349.)

But even under such conditions, white settlement may be handicapped by endemic disease and poor sanitation. Many students believe that if disease can be conquered, the climate of most of Africa will be quite bearable.

Man in Africa

Population. Africa south of the Sahara seems likely to remain a black man's country, for the colored population is vigorous and increasing. In most regions, Europeans have only political and economic control. For several decades, at least, this control may be extended as more plantations and mines, managed by whites, are established. But a counterdevelopment may eventually reverse this trend. Each year, hundreds of thousands of blacks are being educated in mission and government schools. Many of these are attending universities and getting a professional education in law, medicine, science, and engineering. It may not be long before the educated natives, having the advantage of bodies adjusted to the tropical climate, may be capable of taking over many or all of the supervisory positions now almost the exclusive prerogative of the white race.

It is a customary error of Europeans to consider all Africans as belonging to the same racial type. Anthropological studies have revealed many differences among the tribal groups and have uncovered at least a fairly accurate outline of the pre-European history of Africa south of the Sahara. Of those peoples who still survive, the first group to enter Africa were primitive hunters and seed gatherers—the ancestors of the present Pygmies and Bushmen. These were followed by a group of farming peoples, the true Negroes, who apparently drove the hunters from the better lands so that they survived only in the dense equatorial forests and in the Kalahari Desert. The Negroes were followed by several groups of warlike, pastoral peoples (Hamites or dark Caucasians) who conquered and intermixed with some of the Negro tribes, especially in East Africa. Still later, Semitic tribes crossed from Arabia into northern Africa, spread across and around the Sahara and into the northern savannas. These peoples carried Mohammedanism throughout northern Africa to the edge of the equatorial forest. They also instituted the Arab slave trade which tapped the Negro population for slaves from the interior at about the same time that European slavers were enslaving the peoples of the Guinea coast.

The already complex society of the African natives was further upset by the penetration of European traders, miners, planters, missionaries, and colonial officials. The traders connected the almost self-sufficient African tribes with the world-wide commercial economy. Manchester cottons and German knives replaced the equivalent articles produced by native craftsmen, and specialization in a few products for export led to the decline of the native arts. European miners and planters drew native labor from its villages to European compounds where the natives learned many European skills, ideas, and vices. European missionaries further upset the native regime by introducing ideas which bewildered the native by being so different from the practices of many European traders, planters, and officials. The European colonial governments introduced strange new sets of laws, imposed taxes, and raised armies. Especially puzzling to the native were some of the property laws which usurped rights which they had always considered inalienable. The suddenness of this change added to its seriousness. Practically all of these innovations have occurred since 1880 and in any one section the most serious of them occurred within a few years. Today, many of the whites in Africa are frightened lest, when the natives awake from their bewilderment and learn the techniques of the white civilization, they may drive the small white minority from Africa. Large colored armies, trained in the use of modern weapons for a possible European war, may well become not only a reserve of fighting men but a menace to white domination.

Political Control. Politically, Africa is divided as follows:

French colonies and mandates	4,200,000 square miles
British colonies and mandates	3,984,000 square miles
Egypt (under British control)	350,000 square miles
Belgian territory	930,000 square miles
Portuguese territory	788,000 square miles
Italian territory (including Ethiopia)	1,030,000 square miles
Spanish territory	140,000 square miles
Liberia (independent)	40,000 square miles

These areal figures are somewhat misleading, for they do not show the quality of the various possessions. Thus, the British colonies are far superior to the French, for the latter include the huge wastes of the Sahara. Likewise, the Belgian territory is much more valuable than the drier Portuguese and Italian possessions which have roughly the same area. A comparison of a rainfall map with a political map of Africa will give a much better idea of the relative value of the colonial possessions than the above table by itself.

QUESTIONS FOR DISCUSSION

1. Compare Africa and South America as to history and environment.
2. Why does most of Africa belong to European nations while most of South America is independent?
3. The Sahara Desert extends across northern Africa, but the Kalahari extends only part way across southern Africa. Both are trade-wind deserts Why the difference?

Regional Geography

Communications and African Trade. The trade of Africa is with regions outside the continent to an even greater degree than that of South America. So far as trade is concerned, most of the African regions might as well be on separate islands, since, except within the Union of South Africa, there is almost no interregional trade.

The amazing development of transportation routes in recent decades may seem to contradict the preceding statement. However, these routes connect each region with the seaports, and only incidentally connect the various regions with one another. Another reason for the multiplicity of routes is the competition of various seaports. For example, Katanga, the highly mineralized province of southern Belgian Congo, is connected with the sea by British railroads

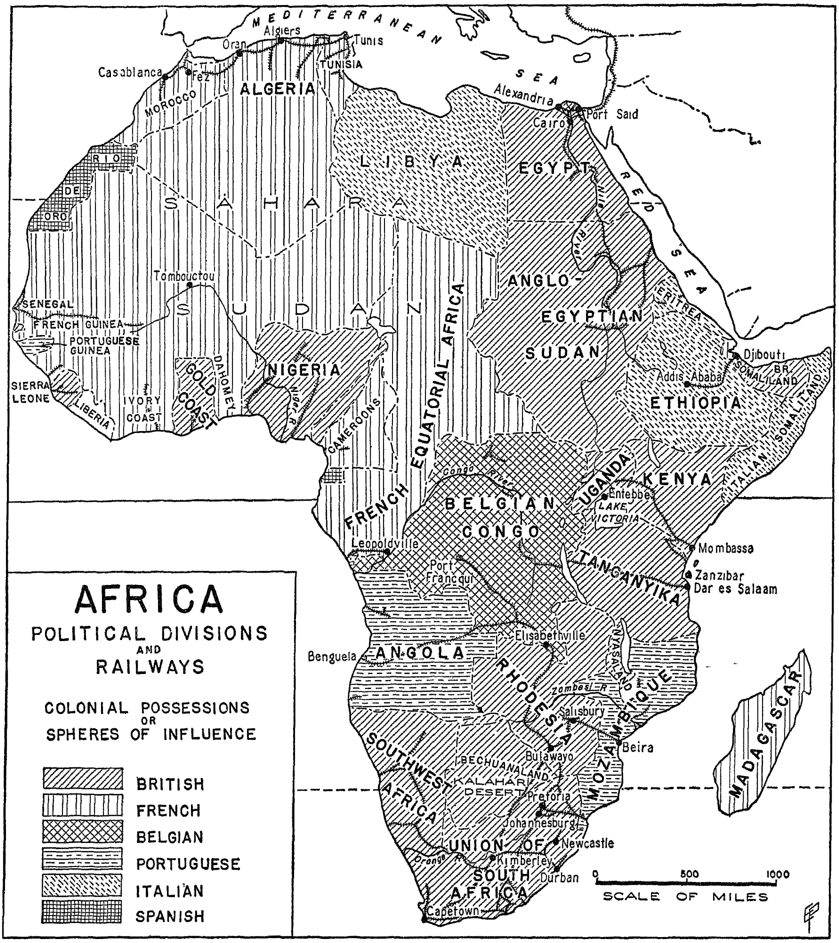


Figure 309.

via the ports of Cape Town, Durban, and Dar es Salaam; by Portuguese railroads via the ports of Benguela and Beira; and by Belgian railroads via Port Francqui. There are also Belgian and British air routes, and the Congo River rail and steamer route. However, these many routes do not imply that there is much through traffic between any two of these ports.

The Small Regions of the Union of South Africa. The Union of South Africa includes several

regions similar to those found in the United States west of the Mississippi and south of San Francisco. Similar regions are also found in Australia. The South African regions are, however, nearer to the equator than the American and Australian equivalents, but this lower latitude is offset by altitude and by the influence of the adjacent oceans. South Africa also differs from America and Australia in having a large, fairly docile, native labor supply.

As in Australia and the American West, many of the agricultural resources of South Africa have been developed slowly because of the greater attraction of mineral wealth. Even today, minerals make up three-fifths of the total value of exports from the Union of South Africa. The agricultural exports—including wool, skins, and fruits—have, however, been increasing and the Union Government has been making strenuous efforts to attract white farmers to settle the land and, thus, further increase the agricultural exports.

The central physical feature of the Union is the high plateau, a continuation of the plateau of central Africa. The geological foundation of the plateau consists of very hard, old rocks which contain many minerals. These rocks have been covered by sedimentary rocks (the Karoo beds) which in the eastern third of South Africa contain considerable coal. These sedimentary strata were penetrated by great sheets of igneous rock (dolerite) which form a resistant hard rock cap over parts of the plateau. All of these beds have been elevated to form the plateau, which has been warped slightly into roughly the shape of a saucer with its highest edge to the southeast. To the south of the plateau escarpment, the Karoo beds have been subjected to folding to form the small mountainous area of southwestern Africa. To the east of the escarpment, the igneous cap is lacking and the Karoo beds have been eroded. Due to the horizontal position of the strata, the land usually descends in a series of steps to the Indian Ocean.

The Mediterranean Region. This land of winter rainfall is about four hundred miles long and rarely more than fifty miles wide. Since much of the land is rugged, its population and products are by no means so important as in similar regions in Chile and California. The narrow valleys are intensively farmed, but the mountain ridges are unutilized. The principal products raised for export are grapes (mostly as raisins and wine), oranges, lemons, and temperate fruits. Most of these are raised by irrigation. Wheat, barley, Turkish tobacco, and other Mediterranean crops are raised largely for consumption within the Union.

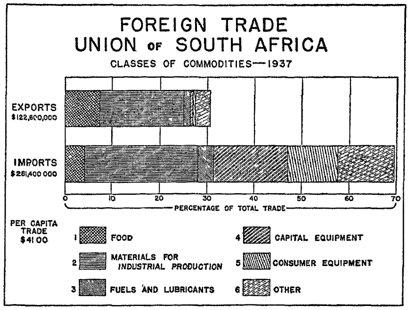


Figure 310. This graph does not include gold exports which in 1937 amounted to $405,000,000.

Cape Town, the capital of the Union, is also the principal port. Its exports are mainly fruits (canned, dried, and frozen), corn, and wool. The great advantage of these exports in world markets is that they are sold six months later than the Northern Hemisphere harvests. Thus, they are able to compete with similar products from the Mediterranean Sea in spite of the higher freight charges.

The Subtropical Eastern Coast. In products and climate, this area roughly resembles the Gulf coast of the United States. The humid coastal strip contains many sugar-cane plantations and also produces such humid subtropical crops as oranges, corn, and sweet potatoes. Away from the coast, the weather is less humid and cotton becomes important. Coal is mined here, especially around Newcastle, which also has an iron and steel industry. Coal and sugar, as well as the mineral and agricultural products of the eastern plateau, are exported through Durban, the second port of the Union.

The Drakensberg. This and adjoining ranges to the north and southwest are but the upturned edge of the central plateau. The escarpment rises to 11,000 feet in the Drakensberg and, almost everywhere, is more than 5000 feet on the southeastern side of the plateau. Over large areas the mountains are extremely rugged and have remained in the hands of the natives. The highest part—Basutoland—has been established as a native state advised by a British commissioner. Here half a million natives live an independent life, working small farms and raising cattle.

The High Veld. This is a treeless, rolling, fertile grassland which, in many ways, resembles the drier parts of the Corn and Winter-wheat Belt of the

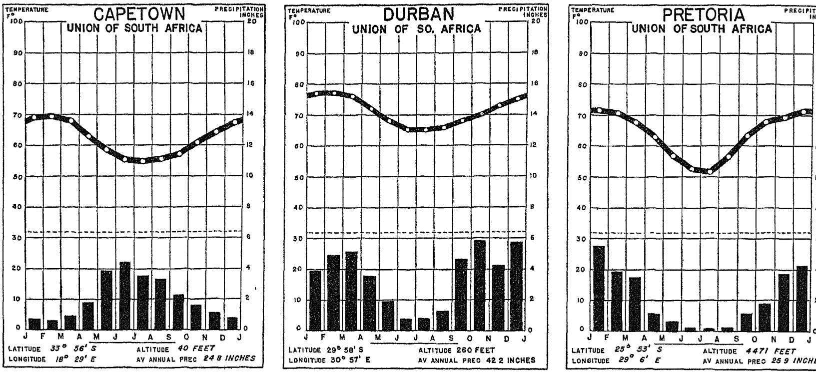


Figure 311 How can you identify these as Southern Hemisphere stations?

United States. Corn is the basic crop and is used as the principal food by natives, whites, and cattle. Comparing this region with the American Corn Belt, sheep—of the Merino type—are considerably more important, the climate is much milder in winter and slightly cooler in summer, and drought and locust pests are a much more serious problem.

Minerals (gold and diamonds) have caused the development of several important cities—especially Johannesburg (380,000), Pretoria (100,000), and Kimberley (40,000). The other settlements on the high veld are small rural centers rather than cities. Johannesburg owes its growth to the Witwatersrand gold field ("the Rand"), by far the greatest gold field in the world. The large local market and the readily available capital have made it one of the leading industrial cities of the Union. Meat chilling, flour milling, furniture making, iron founding, and tobacco manufactures are the chief industries.

The Temperate Grasslands. Fully half of South Africa receives less than fifteen inches of annual rainfall and even this rainfall is undependable. This arid and semiarid half is a great grassland, suited mainly to ranching and, in favored spots, to irrigation and dry farming. Much of the area is included within the Kalahari Desert, but this desert is rarely as barren as the Sahara The unproductive area is limited to a narrow, lowland strip along the Atlantic coast. Inland, on the plateau, it is called a "desert" merely because of its lack of surface water. Usually, there is enough vegetation to support extensive grazing, but wells must be drilled to supply drinking water. Cattle, sheep, and goats are common. The greatest development of these grazing industries has taken place in the area adjacent to the agricultural regions of the Union, and on the high plateau of the mandated territory of South-West Africa.

The Katanga-Rhodesia Mineral Region. The minerals of this area in south central Africa are of great importance, not only in themselves, but also in the impetus they have given to the development of central Africa. Several small but modern cities (Elisabethville, Salisbury, Bulawayo) have grown up in the mineral areas. Plantations and ranches are also developing along the railways to supply food for mining camps and cities. The Katanga province of the southern Belgian Congo has, within two decades, become one of the leading copper areas of the world. It also produces tin, zinc, iron, cobalt, radium, and a small amount of coal. The adjacent parts of Northern Rhodesia were formerly noted for their precious metals, but are now much more important as producers of copper, cobalt, zinc, and vanadium. Southern Rhodesia has produced gold since prehistoric times and gold is still its major mineral product. Asbestos is second in value and chrome ore (chromium) third. In western Southern Rhodesia, there is an important supply of coal which provides much of the fuel for smelting throughout this region.

QUESTIONS FOR DISCUSSION

1. Compare the Union of South Africa with Mexico.
2. Why are sheep and goats generally more important than cattle in South African economy?
3. How is the position of South Africa an advantage?

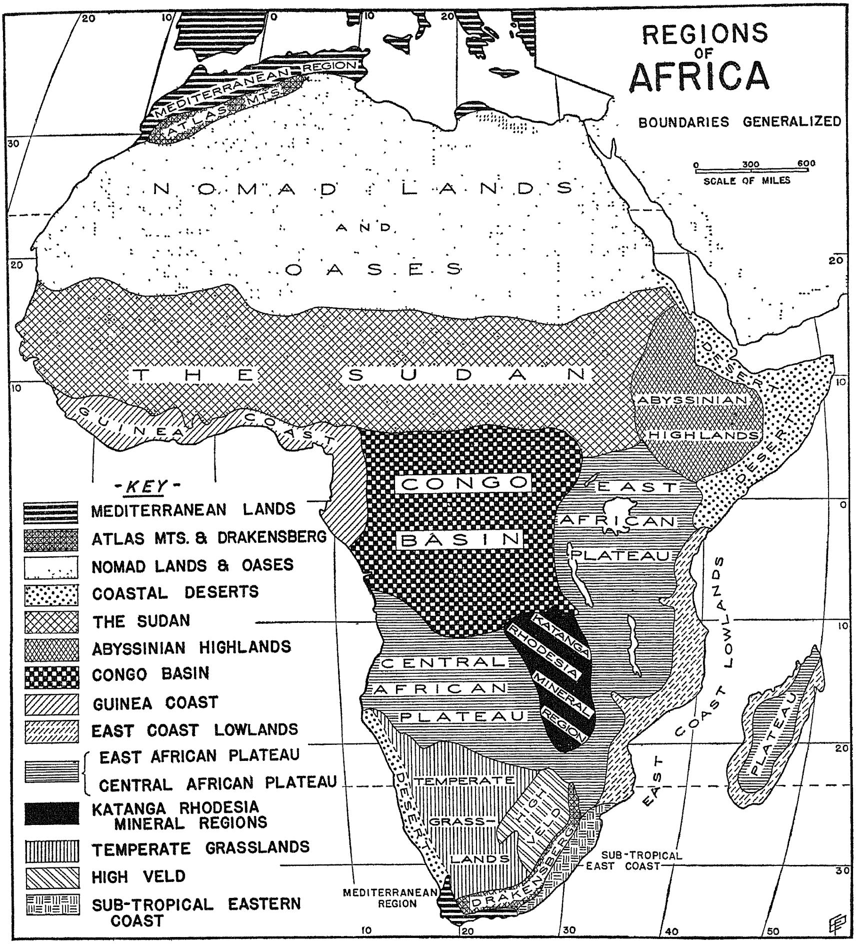


Figure 312. Compare with the regional maps of South America (p 372) and Australia (p 463) To facilitate comparison, similar symbols have been used for regions which are roughly comparable.

The Plateau of South Central and East Africa. Throughout this region is found a rolling plateau of old crystalline rocks, covered by savannas and dry forests. Aside from these common factors, there is considerable variety. On the plateau are found all the types of people described on page 471. The geology is also varied, for the eastern part of the plateau has been faulted to form the Rift Valley of East Africa, the largest faulted valley in the world. Along this fault line, great volcanic activity has covered

large areas with lava and built up volcanic peaks, many of which rise to more than ten thousand feet. These physical features have influenced the soil and also the climate by altering the temperature and rainfall.

The climate is subtropical due to the altitude. Except on the mountains, frost is absent, and disease germs and insects multiply throughout the year. Many large areas which are, climatically, pleasant for habitation have had very little development because of malaria or sleeping sickness. Large savanna areas, apparently well suited for pasture, contain few animals because of the tsetse fly. Another handicap is the brightness of the sun to which is attributed the nervousness which afflicts white settlers in these tropical highlands.

The native animal industries are by far the most important, although they contribute little to trade. Domestic animals (especially cattle) have a religious significance to most of the tribes. Cattle represent wealth, and to kill them except as a religious ceremony is considered wasteful as well as sacrilegious. Each animal has its name and is part of the family. The milk of the cows is used and the hides of dead animals are important for clothing, but the bulk of the meat supply is obtained from wild animals rather than cattle. Grass is important in the ritual of the tribes, as it is the food of their prized animals. A. C. Hollis, in his anthropological study, *The Masai,* translates some common phrases of this pastoral people:

> If a man has a cow which he looks after and it bears, it enables him to live, for he can marry and have children and thus become very rich. . Whenever there is drought the women fasten grass on their clothes and offer up prayers to God. . . . The Masai love grass very much, for they say, "God gave us cattle and grass, we will not separate the things God has given us"

Not all parts of the plateau are suitable for farming. However, in the moister areas agriculture provides a large part of the food supply. Usually, the crops are cultivated by those tribes or people who are considered socially inferior by the dominant pastoral element. The common crops include grains (especially millet and corn), cassava, peanuts, bananas, sugar cane, beans, pumpkins, yams, sweet potatoes, and other vegetables. Some of the more progressive native tribes raise crops for export—for example, cotton raised by the natives of Uganda.

Plantations have been established on the healthier and more accessible parts of the plateau. Usually these are located within twenty-five miles of one of the few railroads or modern roads. The most prosperous plantations are located on the volcanic soils of East Africa. Coffee is the most universal crop, but tobacco, tea, sisal, cotton, and hides are important in some regions. In addition, corn, wheat, sugar, cassava, vegetables, fruit, meat, and dairy products are produced for use on the plantation or for sale to the few thousand European inhabitants in each of the cities.

The plateau, except in a few areas, is not densely populated. Expansion in production is therefore possible, for this land is as fertile as many of the areas of India which have a much denser population. Several obstacles retard development. First, the world market for crops such as coffee, sisal, cotton, and tobacco is limited. The market for meat and hides is less restricted, but the quality of the cattle must be much improved if these African products are to bring good prices. Second, the available labor supply is limited. The mines have attracted many of the more ambitious natives to South and central Africa Other natives are quite satisfied to manage their own farms and herds. Furthermore, the natives are beginning to realize the importance of their labor to the white planter and are demanding higher wages. There are two alternatives: the importation of Hindu coolies and farming with white labor. The use of Hindus would complicate an already difficult racial problem and would introduce a group which would not long be satisfied to remain as laborers. Small farms operated by white owners will hardly produce enough to maintain a minimum European standard of living.

The Eastern Coastal Lowlands. Plantations are much better developed on the hot coastal lowlands than on the plateau. This area has been under European and Arab influence for centuries. Thus, its products have a well-established place in world markets and ready transportation is available. The most common products are coconuts, sugar cane, and sisal. Rice, maize, cassava, and yams are raised largely for local consumption. Zanzibar and Pemba, two islands off the coast, specialize in cloves, and their plantations produce the bulk of the world's supply.

Madagascar. This French island is somewhat greater in size than the mother country. In environment it is but a detached section of adjacent East Africa. It has thus both a plateau area with cattle, coffee, and cotton and a humid eastern coastal plain which produces rice, sugar, coconuts, corn, cassava, and vanilla. The island is also the principal producer of raffia fiber.

The Congo Basin. This large region, drained by the Congo River system, is, geographically, a huge

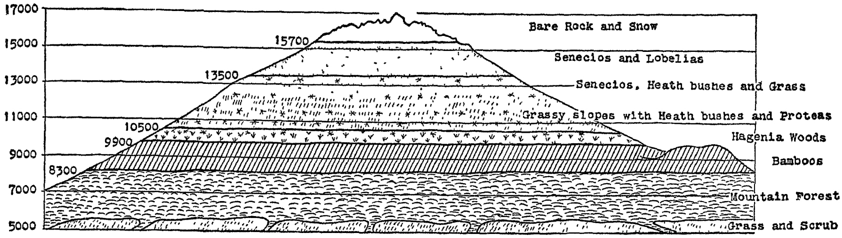


Figure 313. Vegetation on the eastern slope of Mount Kenya, one of the high peaks on the East African Plateau. (Courtesy of the American Museum of Natural History)

depression in the crystalline plateau. It was formed by faulting, and after its formation was covered by layers of sandstone. At present it is a plateau, several thousand feet lower than the East African Plateau. It lacks any striking relief features except the fault scarps at its edge.

Climatically, the area is hot and rainy. The northern half of the basin is covered with a tropical forest, but, in the southern half, the dry season is sufficiently marked to result in a luxuriant grassland with forested areas mainly along the streams. Except in the high Katanga section in the extreme south, the basin is too hot for white settlement, but the altitude (generally 1000 to 2000 feet) prevents the temperatures from being extremely oppressive.

Native agriculture dominates the region; plantations are found principally along some of the through rail and river routes and within several hundred miles of the Atlantic coast Palm oil is the principal export of the forested regions; cotton and tobacco are the principal agricultural exports of the grasslands.

The natives in both forest and grassland areas are of the same racial stock, but their lives are differentiated by the environment. According to a valuable handbook published by the British Museum:

> Among the forest peoples clothing is made of vegetable substances; the bow is the chief weapon and its string is of fiber or cane, basket work belongs to the woven type, rectangular houses are found. Among the inhabitants of the parkland, clothing is made of skins; where the bow is found, the string is of sinew; the spear is the chief weapon; basket work belongs to the coiled type and houses are circular Large states or confederations of tribes have developed in the parklands or on the fringe of the forest where the latter is not sufficiently dense to hinder communication. In the thicker portions the central control of a wide area is impossible, and each village is independent The chief food plants are, in the forest, manioc; the parkland, maize.[1]

[1] British Museum, *Handbook to the Ethnographical Collections*, 2d ed., p 193 Oxford, 1925.

The Congo Basin has been slow to develop due to transportation problems. The rivers are interrupted by numerous falls and expensive portages are thus necessary. Most of the roads and railroads have been oriented toward the Katanga Mineral Region rather than toward the Congo Basin. Finally, an unhealthy coastal strip must be crossed before the interior plateau is reached. Since the soil is moderately productive and the rainfall certain, when transportation is supplied this should become one of the great tropical agricultural regions of the world. The climate is much healthier than that of the Amazon Valley and this region has a much better labor supply. Its great handicap is the lack of a river system as navigable as the Amazon.

The Guinea Coast. The humid, forested coast along the Gulf of Guinea has been exploited for several centuries. The names given to parts of it—Ivory Coast, Slave Coast, Gold Coast—suggest the original articles of trade. Its dense Negro population and its hot, humid climate make it an ideal area for the development of tropical agriculture. Since whites do not care to live here for long periods, the policy of European governments has been to encourage the production of commercial crops by Negro farmers. Thus are produced the cacao, kola, palm oil, and sisal which are the principal agricultural exports.

Several important mineral deposits occur in the forested area Of greatest present importance is the manganese of the Gold Coast. Gold, diamonds, and bauxite are also found in this colony.

The Sudan. North of the forested coastal region, a strip of grassland, more than five hundred miles wide, extends across tropical Africa. It is commonly known by a short form of the Arabic name, *Bilad es Sudan*—"the country of the blacks." Physically, it is a lower continuation of the plateaus of central and South Africa, but its lower elevation and its higher

latitudes give it a warmer and drier climate than the plateaus to the south. Generally, the country is rolling to hilly, although there are several mountainous areas along the escarpments at the southern edge of the plateau.

The Sudan is occupied by Negro farmers who have mixed with and are controlled by Hamitic and Arab pastoral nomads These, in turn, have been conquered by the French and British who control (although rather nominally in large areas) the region. The imposition of European control has stopped the slave trade and safeguarded other trade.

The pastoral industries are most characteristic. Camels and horses are common on the edge of the desert; farther south cattle and sheep replace them. Many of the cattle raisers have the same veneration for their animals as the peoples of East Africa Farming is associated with the animal industries almost to the edge of the desert. Millet is the staple food in the drier north; corn is more important toward the edge of the forest. Other important products are peanuts, sesame, gum arabic, wheat, cotton, tobacco, and rice. The last three of these are grown by irrigation along the Nile and Niger rivers.

Minerals are common on the southern edge of the plateau. They may be widespread, but to date the area has scarcely been explored. The most important mines are the tin mines in central Nigeria.

The Eastern Horn. The Sudan is prevented from extending to the Indian Ocean by the Abyssinian Highlands. This high plateau, really a higher continuation of the East African Plateau, intercepts the winds blowing from the Gulf of Guinea toward the Asiatic summer low-pressure area. Heavy summer rains result which make this plateau a rich potential farming region as well as the source of the Nile floods. East of the plateau, the Eastern Horn is in its rain shadow and is as arid as the Sahara. These arid regions are of little value except in small strips where irrigation is possible. The plateau is, however, a fertile area with a temperate climate suitable for raising subtropical and temperate crops. The Ethiopians have used it for cattle and foodstuffs. Only coffee has been raised for export. Whether the Italian conquerors will be able to overcome the handicaps of isolation and an unfriendly subject people and convert the plateau into a *profitable* colony is still doubtful.

QUESTIONS FOR DISCUSSION

1. Examine a detailed physical map of Africa and trace the Rift Valley (it starts in the Jordan Valley of Palestine). What do you think has been the economic significance of this valley?
2. Outline the difficulties which you think you might face if you started a plantation in tropical Africa. Where would you prefer to start your plantation?

REVIEW QUESTIONS ON CHAPTERS 50 TO 54

1. Compare Australia, latitude for latitude, with northern Africa and southern Europe. What similarities are there in environment and economic development? Does the position of Australia explain some of the differences? What other factors account for differences in resources and development?
2. How may the problem of overpopulation in monsoon Asia be solved? What factors retard a solution of this problem?
3. To what extent are the densely populated areas of India, China, and Africa likely to follow Japan in industrialization? Does industrialization in these areas necessarily mean reduced markets for the industrial regions of Europe and North America?

STATISTICAL APPENDIX

Table I—PRINCIPAL COUNTRIES OF THE WORLD. Area, Population, and Foreign Trade

Country	*Area sq. miles (000's omitted)*	*Population latest official estimate (000's omitted)*	*Population density per square mile*	*Trade (millions of U. S dollars—1938)*					
				Exports to U. S.	*Imports from U. S.*	*Total U S trade*	*All other exports*	*All other imports*	*Total trade*
NORTH AMERICA	8,635 0	177,500							
Alaska	586.4	59	.1						
Canada	3,542 0	10,835	3 1	260 3	467 7	728 0	577 3	209 8	1,515 1
Greenland	736.0	17	02						
Mexico	760.3	17,467	23 0	49 0	62 0	111 0	138.7	46 8	296.3
Newfoundland, Labrador	152 0	290	1.9	6 6	7.7	14 3	17 4	12 8	44.5
United States (Continental)	2,973.8	131,669	44 2	.....	....	. .	3,056.8	1,949 6	5,006 4
CENTRAL AMERICA	212 0	13,118							
British Honduras	8 6	54	6.3	2 3	1 1	3 4	7 7	6.9	.....
Costa Rica	23 0	552	24.0	4 1	5 4	9 5	.....	.....	24.1
Guatemala	42 4	2,200	52 4	9 5	6 9	16 4	6.9	14.1	37.4
Honduras	46 3	920	19 9	5 7	6 3	12 0	4 0	2.8	18.8
Nicaragua	49 5	800	16 2	2 5	2 8	5 3	2 1	0.8	8.2
Panama	28.6	491	17.1	3 4	10.2	...	0 5	7.4	21 5
Salvador	13 2	1,574	119 5	5.7	3.5	9 2	7 8	5.6	22.6
WEST INDIES	95 8	12,045							
Cuba	44 2	3,988	90.3	105 8	76 3	182 1	38.8	29.7	250 6
Dominican Republic	19 3	1,300	67.2	5.7	5.7	11 4	9 7	4.5	25 6
Haiti	10 2	2,600	254.8	3.0	3 6	6 6	3 9	4 0	14 5
Puerto Rico	3 4	1,724	525.8						
SOUTH AMERICA	7,180 6	85,000							
Argentina	1,080 0	12,164	11.3	40 7	86 8	127 5	304.9	448 3	880 7
Bolivia	514 6	3,052	5.9	0.9	5.4	6 3	34.3	19 0	59.6
Brazil	3,286.2	41,478	12.6	97.9	62 0	159 9	198 4	230 9	589 2
Chile	286.4	4,465	15.6	28.2	24.6	52.8	110.6	78.7	242 1
Colombia	444 1	8,893	20.0	49.4	40 9	90 3	42 0	47.1	179 4
Ecuador	110 0	2,500	7.4	2.6	3 3	5 9	8 1	7 0	21.0
Guiana, British	89.5	321	3.6	.....	.....	.....	10 7	9.7	20 4
Guiana, Dutch	54.3	161	3.0						
Guiana, French	34.7	26	0.7						
Paraguay	176 0	900	5.1	1.4	0.6	2 0	6 6	7.5	16 1
Peru	524 8	6,237	12.9	12 8	16 9	29.7	64.4	42.5	136.6
Uruguay	72.2	1,993	27.6	4.7	5.1	9 8	54.2	43 5	107.5
Venezuela	394 0	3,324	9 4	20 0	52 3	72 3	247 5	52.7	372.5
EUROPE	3,787.1	535,000							
Albania	10 6	1,003	94 4	.....	.....	.....	2.9	5 3	8.2
Austria	32 4	6,763	208 9	1.3	0 7	2 0	144.8	242.3	389.1
Belgium[1]	11 8	8,276	704.1	41 7	76 9	118 6	686.8	686.7	1,492 1
Bulgaria	40 0	6,090	152 9	2.2	0 8	3 0	69 5	61.9	134.4
Czechoslovakia	54 2	15,057	277.5	26 2	26.5	52.7	328.6	265 1	646.4
Denmark	16.6	3,656	220 6	3 3	24 8	28 1	333 1	342.9	704.1
Eire (Irish Free State)	26 6	3,013	113 3	1 0	26 9	27 9	115 4	173.8	316 9
Estonia	18 4	1,128	61 4	1.2	1 6	2 8	26.9	27.5	57 2
Finland	132 6	3,739	27.8	18.1	12 0	30 1	166.2	176.1	372 4
France	212 7	41,940	197 2	54.1	133 8	187 9	825 4	1,199.2	2,212 5
Germany[2]	181 0	65,804	363 6	64.5	107 6	172.1	2,183.1	2,313.1	4,668 3
Greece	50 3	6,705	133 4	14 9	8.1	23 0	75.2	124.1	222.3
Hungary	35.9	8,895	247 9	3 5	2.7	6.2	150.7	117 7	274.6
Iceland	39.7	109	2.7	1.2	0.1	1 3	10.1	9 9	21 3
Italy	119.7	42,625	356 0	41 2	58 3	99 5	503 8	532.7	1,136 0
Latvia	25.4	1,939	76 3	0.6	1.3	1.9	43 3	42.7	87 9
Lithuania	21.5	2,476	115 1	0.9	0.7	1.6	38 5	37.2	77.3
Luxemburg	1.0	303	303.3			included with Belgium			
Netherlands	13.2	8,400	623.1	31.4	96.8	128 2	534.2	666 9	1,329.3
Norway	119 1	2,871	24.1	15 7	22 6	38 3	179 6	273.8	491.7
Poland	150.0	33,024	220 2	13.4	24 7	38 1	211.0	221 2	470.3
Portugal	35 9	7,177	201 7	3 9	10 9	14 8	46.3	90 0	151 1
Rumania	113 9	18,792	165 0	2 5	6.3	8 8	154 6	128 8	292 2
Spain	194 2	24,242	124.8	12.2	9.2	21.4	.....	. ...	.. ..
Sweden	158 5	6,233	39 4	45.1	64 2	109 3	423.3	462.9	995 5
Switzerland	15 9	4,145	260 0	23 0	10.6	33.6	277 8	355.0	666 4

[1] Foreign trade includes Luxemburg [2] Does not include Austria and Czechoslovakia

Table I—PRINCIPAL COUNTRIES OF THE WORLD. Area, Population, and Foreign Trade—*Continued*

Country	*Area sq miles (000's omitted)*	*Population latest official estimate (000's omitted)*	*Population density per square mile*	*Trade (millions of U. S. dollars—1938)* Exports to U. S	Imports from U. S	Total U. S trade	All other exports	All other imports	Total trade
EUROPE—Continued									
U.S.S R (Soviet Union)	8,244.2	168,000	20.4	24.1	69.7	93.8	326.6	131.5	553.9
United Kingdom	94.3	46,755	495.9	118.2	521.1	639.3	2,158.9	3,986.6	6,784.8
England and Wales	58.3	39,948	685.2						
Scotland	30.4	4,934	162.3						
Northern Ireland	5.2	1,280	53.8						
Yugoslavia	96.0	14,730	153.4	3.8	2.5	6.3	112.6	112.3	231.2
ASIA	16,205.5	1,100,000							
Afghanistan	251.0	7,000	27.9						
Arabia	1,000.0	7,000	7.0						
Burma	233.5	14,667	62.8	0.2	2.3	2.5	172.5	73.6	248.6
Ceylon	25.3	5,463	215.7	16.3	1.3	17.6	87.9	84.9	190.4
China (Dominion)	4,314.2	454,600	104.9	47.2	34.8	82.0	177.1	226.3	485.4
China Proper	1,555.0	450,400	289.6						
Manchuria (Manchukuo)	364.0	29,600	81.3	.....	.....	.....	160.8	326.9	487.7
Mongolia	1,368.0	670	0.5						
Sinkiang (Chinese Turkistan)	550.0	2,700	4.9						
Tibet	463.0	1,500	3.2						
French Indo-China	284.9	23,300	78.3	7.1	3.1	10.2	74.3	51.8	136.3
India and Dependencies	1,575.3	338,170	199.6	58.3	33.4	91.7	558.5	528.1	1,178.3
British India	862.8	256,859	245.3						
Baluchistan	134.6	869	6.5						
Native States	712.5	81,238	114.3						
Iran (Persia)	628.0	10,000	15.9	3.2	9.1	12.3	137.7	81.7	231.7
Iraq	143.3	3,300	23.0	3.1	2.7	5.8	14.5	42.8	63.1
Japanese Empire	260.5	90,396	346.8						
Japan Proper	147.5	68,195	462.0	126.8	239.6	366.4	638.4	518.1	1,522.9
Chosen (Korea)	85.2	21,058	247.0	.....	.....	.....	246.5	295.6	542.1
Karafuto (Sakhalin)	13.9	332	23.9						
Taiwan (Formosa)	13.8	4,593	331.8	.....	.....	....	125.0	102.3	227.3
Malaya, British	52.6	4,418	82.5	112.3	8.9	121.2	212.8	304.7	638.7
Federated Malay States	27.4	1,713	62.6						
Non-Federated Malay States	22.0	1,528	69.5						
Straits Settlements	1.5	1,114	742.7						
Netherlands Indies	733.5	63,500	86.4	68.8	27.5	96.3	290.5	234.9	621.7
Borneo	206.1	2,195	10.7	.....	....	.....	7.3	3.2	10.5
Java and Madura	51.2	41,718	814.8						
Sumatra	163.1	7,661	47.0						
British North Borneo	31.1	270	8.7	.....	.....	.....	7.3	3.2	10.5
Brunei	2.5	30	12.0	.....	.....	.....	2.4	1.2	3.6
Nepal	54.0	5,600	103.7						
Palestine (British Mandate)	8.9	1,140	128.3	0.6	3.2	3.8	23.9	66.4	94.1
Philippine Islands	114.4	13,055	114.1	94.3	86.5	180.8	21.5	46.1	248.4
Sarawak	50.0	600	12.0	.....	.....	....	16.4	11.5	27.9
Syria and Lebanon (French Mandate)	77.2	3,200	41.4	3.2	2.7	5.9	12.8	32.3	51.0
Thailand (Siam)	200.2	12,743	63.6	0.3	3.3	3.6	71.7	43.1	118.4
Transjordania	15.4	300	19.5						
Turkey (Europe and Asia)	294.5	15,200	51.6	19.0	13.2	32.2	96.1	105.7	234.0
AUSTRALASIA	3,091.7	10,000							
Australia	2,974.6	6,706	2.3	8.7	68.8	77.5	509.4	447.6	1,034.5
Fiji Islands (British)	7.4	157	21.2	....	.....	.....	7.6	6.6	14.2
Guam (U. S.)	0.2	22	110.0	0.4	0.08	0.48			
Hawaiian Islands (U. S)	6.4	368	57.5	101.2	96.6	197.8			
New Zealand	103.4	1,557	15.0	6.6	23.4	30.0	221.5	191.6	443.1
Samoan Islands (U. S)	0.1	13	130.0	0.2	0.1	0.3	1.0	0.7	2.0

Table I—PRINCIPAL COUNTRIES OF THE WORLD. Area, Population, and Foreign Trade—*Continued*

Country	*Area sq. miles (000's omitted)*	*Population latest official estimate (000's omitted)*	*Population density per square mile*	*Trade (millions of U. S. dollars—1938)*					
				Exports to U. S.	*Imports from U S*	*Total U S trade*	*All other exports*	*All other imports*	*Total trade*
AFRICA..................	11,402.3	150,000							
INDEPENDENT COUNTRIES									
Egypt....	386 0	15,230	39.4	4.8	13.3	18.1	138.6	167.2	323.9
Egypt (excluding desert).	13.6	15,230	1,119 8						
Liberia........	46.3	2,500	54.0						
INTERNATIONAL (British, French, Italian, and Spanish)									
Tangier Zone of Morocco..	0 2	51	255 0						
BELGIAN SPHERE OF INFLUENCE									
Belgian Congo...... . ..	920.9	10,000	10 9	.. .	.. .	.....	67.8	35.2	103.0
BRITISH SPHERE OF INFLUENCE									
Anglo-Egyptian Sudan...	1,008.1	5,729	5.9	.. ..	... .	.....	26.1	27 4	53.5
Basutoland....	11.7	499	42 7						
Bechuanaland....... ..	275.0	153	0.6		included with Union of South Africa				
British East Africa..... ..	687 0	15,894	23.1						
Kenya................	225 1	3,085	13.7	.. ..	.....	.. ..	44.0	35.6	79.6
Tanganyika......... ..	366 6	5,039	13.7	....	.....	....	21.3	15 4	36.7
Uganda Protectorate ...	94 2	3,620	38 4			included with Kenya			
Zanzibar Protectorate ..	1 0	235	235 0						
Pemba........... ...	0 4	97	242.5						
Zanzibar.............	0 6	138	230.0						
British Somaliland.......	68 0	345	5.1						
British West Africa	499.6	16,278	32.6						
Gambia.......	4.0	208	52.0						
Gold Coast, Ashanti, and Northern Territory..	91.7	3,045	33.2	... .	. ...	.....	53.8	35.4	89.2
Nigeria.......	372.7	19,350	51.9	.....	.....	.....	52.7	43.0	95.7
Sierra Leone..........	30 9	1,800	58.2	. ...	....	. ...	12 0	7.3	19 3
Cameroons (Mandate)... .	34.2	770	22.8						
Mauritius............. .	0.7	403	575.7	.....	... .	.....	13.2	10 8	24 0
Northern Rhodesia......	288.0	1,382	4.8	.....	.....	.....	50.8	16 8	67.6
Nyasaland Protectorate.. .	47.9	1,604	33 5						
Southern Rhodesia.......	150 3	1,220	8.1	.....	.....	.....	51 6	41.0	92.6
Southwest Africa (Union of South Africa Mandate).	322 4	259	0.8	.....	....	.....	14.6	9 4	24.0
Swaziland.......	6 7	113	16 9		included with Union of South Africa				
Union of South Africa....	471.9	8,488	18 0	16.0	70 1	86 1	446 1	389 1	921.3
FRENCH SPHERE OF INFLUENCE									
Algeria.....	222.2	6,910	31.1	....	.. ..	.....	179 8	157 8	337.6
Cameroon (Mandate)	166.5	2,226	13 4	.....	.....	.....	9.1	9 0	18.1
French Equatorial Africa.	915.1	3,200	3 9	.....	. .	.....	8 3	8.0	16.3
French West Africa........	1,799.1	14,400	9.9	....	.....	.. .	38.6	43.7	82.3
Nigeria..................	455.4	19,350	51.9						
Madagascar..	238.0	3,800	16.0	.....	. .	.	20.5	16.3	36.8
Morocco................	162.2	5,500	33.9	.....	.....	.....	43.0	61.0	104 0
Tunisia	48.3	2,500	51 7	.....	.. .	...	51.3	57.2	108 5
ITALIAN SPHERE OF INFLUENCE									
Eritrea..............	45.8	598	13.1	.....	.....	.....	7.4	88.4	95.8
Ethiopia.................	347.5	5,500	15.8						
Italian Somaliland.... ...	194.0	995	5.1	.....	.. .	.....	4.4	13 2	17.6
Libya..................	633 1	718	1.7						
PORTUGUESE SPHERE OF INFLUENCE									
Angola (Port W Africa)...	486.1	2,700	5.6	.....	. ..	.....	13 4	8.5	21.9
Mozambique (Port.E.Africa)	297.9	4,050	13.6	.....	.....	.....	13 5	16 8	30.3
SPANISH SPHERE OF INFLUENCE									
Rio de Oro, Adrar, and Ifni	110.2	20	0 2						
Spanish Morocco..........	13.1	750	57.3	.. .	...	.....	1.7	5.6	7 3

Table II—COMPARATIVE * ECONOMIC DATA FOR SELECTED COUNTRIES

Country	Distribution of population according to selected occupational groups—latest available data—in percentage of total employed: Agriculture, forestry, and fisheries	Manufacturing and mechanical industries	Extraction of minerals	Trade and transportation	Rate of population increase (per thousand)	Yield of wheat (bushels per acre) (latest 3-year average)	Thousands of metric tons of coal and lignite mined 1937	Thousands of barrels (42 U S gallons) of petroleum produced 1937	Thousands of metric tons of pig iron produced 1937	Potential water power 1935 (thousands of horsepower)	Developed water power 1935 (thousands of horsepower)	Number of persons per cotton spindle 1938	Number of persons per telephone instrument 1938	Number of persons per automobile 1938	Railway mileage 1937	Merchant marine (thousands of gross tons) 1938
EUROPE																
Belgium	19.1	39.9	6.6	18.3	3.8	40.5	29,681	....	3,843	.....	16	4.2	21	35	3,209	431
Denmark	34.8	27.0	...	16.7	6.5	44.2	......	....	......	20	11	....	8	24	3,326	1,130
Eire (Irish Free State)	52.1	14.5	0.2	13.5	5.5	32.4	114	....	......	...	....	....	75	45		
Finland	63.4	14.4	0.6	7.4	6.0	26.7	.. ....	....	......	1,800	380	....	22	83	3,533	580
France	38.3	31.2	2.0	17.1	−0.5	22.6	44,319	557	7,916	5,400	4,300	4.2	27	18	40,348	
Germany	30.5	38.1	3.2	22.4	7.1	35.3	369,193	2,187	15,957	2,800	2,000	5.9	18	42	36,256	
Greece	53.7	15.7	0.2	11.5	16.2	13.9	......	....	.....	250	10	.....	154	501	......	1,889
Hungary	58.2	18.6	1.1	8.2	5.6	21.9	823	....	358	175	5	....	60	431	4,773	
Italy	46.3	30.4		12.9	11.5	21.6	374	151	863	5,800	3,800	7.9	71	93	11,383	
Netherlands	20.6	37.2	1.6	23.3	9.4	42.7	11,873	....	.....	17	1	6.9	20	57		
Norway	35.3	26.5		21.8	4.3	29.9	659	....	......	12,000	2,400	....	13	32	2,484	
Poland	75.9	8.7	0.7	5.6	12.0	18.2	36,218	3,604	724	1,400	90	18.8	121	784	13,375	
Rumania	79.6	7.8	0.2	4.5	9.6	16.8	276	51,399	......	1,600	109	....	231	722	7,363	101
Spain	56.1	19.3	1.6	7.8	9.9	11.1	7,017	....	355	4,000	1,400	14.2	81	196	10,117	959
Sweden	40.7	30.2	0.8	14.3	2.1	35.3	424	....	650	5,000	1,800	...	8	29	10,504	
Switzerland	21.3	44.6	0.4	19.0	3.9	31.7	....	....	......	2,500	2,350	3.3	10	55	3,677	
U.S.S.R.	84.9	5.7	0.2	2.9	22.5	10.8	127,000	199,475	14,520	8,425	1,000	16.7	177	252	50,725	1,281
United Kingdom	6.8	39.7	7.5	20.9	3.2	36.7	236,936	....	8,497	850	400	1.2	15	21	23,518	
Yugoslavia	82.0	7.7	0.3	3.9	14.5	18.8	400	....	......	3,000	250	.....	250	829	6,926	387
OTHER COUNTRIES																
Argentina	16.8	26.6	..	12.8	13.8	13.9	.....	16,354	.....	5,000	35	.....	32	46	23,704	303
Australia	22.9	31.2	2.9	24.3	7.0	12.1	15,700	....	700	600	37	.....	11	9	31,891	
Brazil	....	....	...	....	...	....	757	....	......	25,000	700	15.2	172	281	19,676	486
Canada	35.0	26.9	1.6	20.8	11.1	9.7	9,340	1,417	989	18,000	7,547	9.5	8	8	42,270	
China	(largely agricultural)					....	33,250	....	.....	20,000	3	104.7	2,649	9,201	6,367	473
Egypt	67.0	10.4	0.2	12.0	14.5	31.4	....	1,149	......	....	600	...	251	470		
India	67.1	10.3	0.2	7.0	8.8	10.9	24,600	9,852	1,600	27,000	410	36.2	3,384	3,164	43,021	
Japan	50.3	18.5	1.0	20.2	11.8	26.9	41,803	1,871	2,869	8,600	4,200	5.4	52	389	18,776	
Mexico	67.8	13.9		7.1	17.7	9.6	990	46,905	......	6,000	450	21.0	126	189	14,569	55
Netherlands	(largely agricultural)					....	1,170	52,214	.....	......	......	.....	1,389	825		
Union of South Africa	52.4	12.2	5.1	14.8	14.1	7.2	13,574	....	.....	1,600	7	.....	45	24	16,203	
United States	22.0	28.9	2.0	20.4	6.1	13.3	457,575	1,277,653	37,750	42,000	16,075	4.8	6	4	238,539	

* Due to national differences in the methods of collecting statistics, data are not always strictly comparable

Table III—GRAIN, POTATO, AND ANIMAL PRODUCTION IN SELECTED COUNTRIES *

Country	Corn	Wheat	Oats	Rye	Barley	Rice[1]	All grains[2] Total	All grains[2] Bushels per capita	Potatoes Total	Potatoes Bushels per capita	Potatoes Bushels per acre	Hogs[2] per capita	Cattle per capita	Sheep per capita
Canada	8	350	395	11	102	....	823	78.4	71	6.5	133.8	0.4	0.9	0.3
United States	2,542	931	1,054	55	252	1.5	4,395	35.2	391	3.0	123.1	0.5	0.6	0.4
Argentina	213	336	52	11	22	....	586	48.8	34	2.7	101.1	0.3	2.6	3.3
Denmark	....	17	79	12	62	....	147	42.0	49	13.4	246.2	0.9	0.9	0.1
Eire	....	8	39	...	5	....	50	16.7	101	33.4	309.9	0.3	1.3	1.0
Finland	....	8	56	15	9	....	69	19.7	49	13.1	213.7	0.1	0.6	0.3
France	25	345	375	32	58	....	....	....	541	12.8	154.0	0.1	0.3	0.2
Germany	....	205	439	339	192	....	993	15.1	2,032	30.8	284.8	0.4	0.3	0.1
Hungary	102	97	19	31	31	....	199	22.6	95	10.6	130.6	0.3	0.2	0.1
Italy	116	297	43	5	11	1.1	491	11.7	106	2.4	109.3	0.1	0.2	0.2
Norway	....	17	13	0.4	6	...	21	7.5	32	11.1	247.2	0.2	0.4	0.6
Poland	5	84	183	272	66	....	579	17.5	1,389	42.0	188.7	0.2	0.3	0.1
Rumania	201	182	32	26	38	....	388	20.4	78	4.1	133.4	0.2	0.2	0.7
Switzerland	....	6	2	1	...	...	8	2.0	30	7.2	247.5	0.3	0.5	
United Kingdom	....	73	140	..	42	...	250	5.4	184	3.9	256.7	0.1	0.2	0.5
U.S.S.R.[2]	153	925	1,008	881	291	....	....	....	1,758	10.4	119.6	0.1	0.3	0.4
Yugoslavia	187	111	23	9	19	....	210	15.0	60[2]	4.0	92.3[2]	0.2	0.2	0.5
Union of South Africa	106	17	6	..	1	....	88	11.0	....	...	....	0.1	1.3	4.4
Australia	7	145	22	[3]	8	....	177	26.4	13[2]	1.9	93.2[2]	0.1	2.1	16.4
China	241	...	....	...	293	....	....	....	....	...	....	0.2	0.1	0.1
India	91	402	....	...	108	72.3	....	....	....	...	....	...	0.6	0.1
Japan	3	45	11	[3]	64	20.6	681	9.9	35	0.5				
New Zealand	...	6	3	[3]	...	....	8	5.3	5	3.3	140.0	0.4	2.7	19.1

* Grains and potatoes in millions of bushels, 1938 unless otherwise indicated

[1] Billion pounds [2] 1935 data used [3] Negligible

Table IV—CORN PRODUCTION FOR SELECTED COUNTRIES AND STATES, 1921-1938

(production in millions of bushels; yield in bushels per acre)

Country or State	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
UNITED STATES																		
Production	3,069	2,906	3,054	2,309	2,917	2,692	2,763	2,819	2,535	2,060	2,589	2,907	2,352	1,377	2,304	1,507	2,651	2,542
Yield	*29.6*	*28.3*	*29.3*	*22.7*	*28.8*	*27.0*	*28.1*	*28.0*	*25.9*	*20.4*	*24.4*	*26.8*	*22.8*	*15.7*	*23.8*	*16.2*	*28.3*	*27.7*
PENNSYLVANIA																		
Production	76	69	62	48	72	57	50	50	46	27	62	46	51	53	61	55	63	60
Yield	*47.5*	*44.0*	*40.0*	*36.5*	*51.0*	*41.0*	*39.5*	*39.0*	*35.5*	*22.0*	*49.5*	*37.0*	*39.5*	*43.5*	*44.0*	*41.5*	*46.0*	*43.5*
IOWA																		
Production	431	466	436	306	493	436	387	465	430	385	386	510	455	201	373	190	499	469
Yield	*41.8*	*45.0*	*40.5*	*28.0*	*43.9*	*39.0*	*35.5*	*41.5*	*39.5*	*34.0*	*32.9*	*43.0*	*40.0*	*23.0*	*38.0*	*17.7*	*45.0*	*45.5*
KANSAS																		
Production	97	98	122	131	110	61	177	179	160	81	115	136	80	11	39	11	29	45
Yield	*22.2*	*19.3*	*21.7*	*21.7*	*16.6*	*11.0*	*30.0*	*27.0*	*15.5*	*12.0*	*17.5*	*18.5*	*11.5*	*2.8*	*9.0*	*4.0*	*12.0*	*20.0*
GEORGIA																		
Production	70	53	49	46	42	55	55	38	41	36	37	39	39	39	49	34	48	53
Yield	*15.0*	*12.0*	*12.2*	*11.5*	*10.7*	*14.5*	*14.0*	*10.5*	*12.0*	*10.5*	*10.0*	*10.0*	*10.5*	*10.0*	*10.5*	*8.0*	*11.5*	*11.5*
MEXICO																		
Production	61	68	101	106	73	82	82	86	58	54	84	78	76	68	66	63	64	67
Yield	*24.0*	*15.9*	*12.8*	*13.2*	*10.5*	*10.9*	*10.2*	*11.1*	*8.2*	*7.1*	*10.1*	*9.7*	*9.6*	*9.2*	*9.0*	*8.9*	*8.7*	*9.1*
ARGENTINA																		
Production	230	176	277	186	280	321	306	240	281	420	285	299	268	246	396	360	174	213
Yield	*28.5*	*22.4*	*32.7*	*20.3*	*26.3*	*30.3*	*28.5*	*26.6*	*26.9*	*36.2*	*29.9*	*31.4*	*28.6*	*25.3*	*31.3*	*30.1*	*23.8*	*24.6*
ITALY																		
Production	92	77	89	106	110	118	87	65	100	118	77	119	102	126	98	120	134	116
Yield	*24.8*	*20.2*	*23.5*	*27.8*	*28.6*	*31.3*	*24.7*	*17.5*	*26.8*	*31.5*	*22.2*	*33.2*	*28.8*	*34.3*	*27.5*	*32.6*	*36.8*	*31.0*
RUMANIA																		
Production	111	120	151	155	164	239	139	109	251	178	239	236	179	191	189	221	187	201
Yield	*13.0*	*14.2*	*18.0*	*17.4*	*16.9*	*23.9*	*13.3*	*9.9*	*21.2*	*16.3*	*20.3*	*20.0*	*15.0*	*15.4*	*14.8*	*17.0*	*14.7*	*16.2*
YUGOSLAVIA																		
Production	74	89	85	149	149	134	83	72	163	136	126	189	142	203	93	204	210	187
Yield	*15.9*	*18.9*	*19.0*	*30.8*	*28.6*	*27.2*	*16.3*	*14.3*	*27.8*	*23.0*	*20.4*	*30.3*	*22.6*	*30.9*	*13.9*	*30.5*	*31.6*	*27.5*
AUSTRALIA																		
Production	7	7	8	12	7	7	11	8	8	8	7	5	7	8	7	7		
Yield	*25.6*	*23.6*	*25.7*	*31.2*	*25.0*	*24.4*	*28.4*	*26.4*	*26.7*	*27.4*	*26.3*	*22.2*	*24.7*	*27.5*	*25.1*	*22.8*		
INDIA																		
Production	83	98	76	87	68	75	77	90	82	98	96	91	86	76	92	91		
Yield	*13.5*	*15.6*	*12.9*	*15.0*	*12.7*	*13.8*	*13.8*	*15.2*	*12.4*	*15.0*	*13.6*	*13.1*	*12.3*	*12.6*	*10.3*	*14.7*		

Table V—WHEAT PRODUCTION FOR SELECTED COUNTRIES AND STATES, 1921-1938

(production in millions of bushels; yield in bushels per acre)

Country or State	*1921*	*1922*	*1923*	*1924*	*1925*	*1926*	*1927*	*1928*	*1929*	*1930*	*1931*	*1932*	*1933*	*1934*	*1935*	*1936*	*1937*	*1938*
UNITED STATES																		
Production.......	815	868	797	864	676	831	878	915	813	858	892	746	529	497	603	627	876	931
Yield...........	*12.8*	*13.9*	*13.4*	*16.5*	*12.9*	*14.8*	*14.9*	*15.7*	*13.0*	*14.0*	*16.2*	*13.1*	*11.0*	*11.8*	*12.1*	*12.8*	*13.6*	*13.3*
PENNSYLVANIA																		
Production.......	24	25	24	19	23	24	20	17	20	27	20	13	16	15	19	20	24	22
Yield..........	*17.5*	*18.5*	*19.0*	*16.5*	*20.0*	*20.0*	*18.5*	*15.5*	*18.0*	*22.0*	*22.0*	*15.0*	*18.0*	*17.0*	*21.0*			
KANSAS																		
Production.....	134	125	84	157	81	154	114	184	149	167	240	120	58	80	60	120	158	152
Yield...........	*12.7*	*12.8*	*10.1*	*16.0*	*9.2*	*14.8*	*11.2*	*17.0*	*12.3*	*13.5*	*19.0*	*11.6*	*8.5*	*9.2*	*9.1*			
NORTH DAKOTA																		
Production.....	88	130	69	133	114	78	134	155	100	108	40	110	72	21	54	19	57	80
Yield..........	*8.2*	*13.8*	*8.2*	*15.3*	*12.3*	*8.6*	*12.9*	*14.4*	*9.6*	*11.0*	*6.4*	*10.4*	*7.1*	*5.6*	*6.7*			
WASHINGTON																		
Production.......	50	28	51	25	34	38	53	46	43	38	41	40	43	37	46	47	51	52
Yield...........	*23.2*	*13.6*	*25.3*	*14.1*	*17.5*	*19.1*	*24.6*	*21.4*	*18.6*	*16.6*	*17.3*	*18.3*	*20.2*	*19.8*	*23.1*			
CANADA																		
Production.....	301	400	474	262	395	407	480	567	305	421	304	443	282	276	274	219	180	350
Yield........	*13.0*	*17.8*	*21.7*	*11.9*	*19.0*	*17.8*	*21.4*	*23.5*	*12.1*	*16.9*	*11.6*	*16.3*	*10.8*	*11.5*	*11.4*	*8.6*	*7.0*	*13.5*
MANITOBA																		
Production....	39	60	33	41	34	47	31	52	29	44	27	44	33	37				
Yield...........	*11.2*	*19.3*	*11.3*	*16.9*	*17.7*	*22.6*	*14.0*	*19.7*	*12.4*	*17.7*	*10.5*	*16.0*	*12.9*	*14.6*				
ARGENTINA																		
Production.......	191	196	248	191	191	221	239	345	163	232	220	241	286	240	144	249	185	336
Yield.......	*13.4*	*12.0*	*14.4*	*10.7*	*10.0*	*11.5*	*12.1*	*15.6*	*10.2*	*11.8*	*13.7*	*13.5*	*15.9*	*14.0*	*12.1*	*15.7*	*12.1*	
BELGIUM																		
Production.	15	11	13	13	14	13	16	17	13	13	14	15	15	16	14	16	16	20
Yield	*42.3*	*35.4*	*38.4*	*38.2*	*39.7*	*36.2*	*41.6*	*42.2*	*37.1*	*32.2*	*36.3*	*39.8*	*40.5*	*43.5*	*35.7*	*38.1*	*36.6*	*46.8*
ENGLAND																		
Production.	69	61	56	50	50	48	52	47	47	39	35	41	59	65	61	51	52	69
Yield.	*35.6*	*31.9*	*32.7*	*33.0*	*34.0*	*30.6*	*32.5*	*34.0*	*29.7*	*29.7*	*30.1*	*32.0*	*35.4*	*37.1*	*34.2*	*30.2*	*30.0*	*37.9*
FRANCE																		
Production.	323	243	276	281	330	232	276	281	337	228	264	334	362	339	279	255	258	345
Yield.	*24.3*	*18.6*	*20.2*	*20.6*	*23.8*	*17.9*	*21.1*	*21.7*	*25.3*	*17.2*	*20.6*	*24.8*	*26.8*	*25.3*	*21.1*	*19.8*	*20.5*	*27.6*
HUNGARY																		
Production.......	53	55	68	52	72	75	77	99	75	84	69	64	96	65	74	88	72	97
Yield	*18.3*	*15.5*	*20.4*	*14.7*	*20.3*	*20.2*	*19.1*	*23.9*	*20.2*	*20.1*	*17.3*	*17.0*	*24.6*	*17.1*	*18.5*	*21.8*	*19.7*	*24.2*
ITALY																		
Production.......	194	162	225	170	241	221	196	229	260	210	248	277	299	233	283	225	296	297
Yield	*16.3*	*14.1*	*19.5*	*15.1*	*20.6*	*18.2*	*15.9*	*18.6*	*22.1*	*17.6*	*20.5*	*22.7*	*23.7*	*19.0*	*22.8*	*17.7*	*23.2*	*23.9*
RUMANIA																		
Production.......	79	92	102	70	105	111	97	116	100	131	135	56	119	77	103	129	138	182
Yield......	*12.8*	*14.1*	*15.4*	*9.0*	*12.8*	*13.5*	*12.6*	*14.6*	*14.7*	*17.3*	*15.8*	*7.8*	*15.5*	*10.1*	*13.4*	*15.2*	*15.7*	*19.5*
AUSTRALIA																		
Production.......	129	109	126	165	115	161	118	160	127	213	171	214	177	133	140	151	188	145
Yield	*13.3*	*11.2*	*13.2*	*15.2*	*11.2*	*14.5*	*12.8*	*10.8*	*8.5*	*11.7*	*12.2*	*13.6*	*11.9*	*10.6*	*11.7*	*12.3*	*13.7*	*10.3*
INDIA																		
Production......	250	367	372	361	331	325	335	291	321	391	347	337	353	351	363	352	364	402
Yield...	*9.7*	*13.1*	*12.1*	*11.6*	*10.4*	*10.7*	*10.7*	*9.0*	*10.0*	*12.3*	*10.8*	*10.0*	*10.7*	*9.8*	*10.5*	*10.5*	*11.0*	*11.3*

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   - *World Economic Review*
   - *Foreign Commerce Yearbook*
   - *Statistical Abstract of the United States* (annual)
   - *Yearbook of Agriculture* (annual), now published with a separate statistical appendix
   - *Minerals Yearbook* (annual), with a separate statistical appendix
   - *Census of the United States*
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   - *The United Kingdom, an Industrial, Commercial and Financial Handbook* (1930) and similar volumes on other countries (various dates)
2. *State governments.* The various bureaus of the state governments publish many pamphlets and volumes of geographic interest Of special value are those prepared by state geological surveys, agricultural experiment stations, planning boards, and tourist bureaus.
3. *British Empire.* British publications originating in the United Kingdom are published by His Majesty's Stationery Office, London, and are obtainable in the United States through the British Library of Information, Rockefeller Plaza, New York. Of general value are:
   - *Statistical Abstract for the British Empire* (annual)
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SELECTED LISTS OF CHARTS, MAPS, AND GRAPHS

CLIMATIC CHARTS (arranged by latitude)

NORTH

SOUTH

CONTOUR (TOPOGRAPHIC) MAPS

FOREIGN TRADE GRAPHS

UNITED STATES MAPS

WORLD MAPS

REVIEW QUESTIONS

INDEX

Note: Text references are in arabic numerals, e g., 165, or in boldface numerals, e.g., **165**. The boldface type identifies a definition or explanation of the term indexed or, for places or regions, a regional description of the area referred to. References to the maps, charts, and other figures are in italics, e.g, *165*. References to the half-tone plates are in roman numerals, e g, Pl. XII A; references to the analyses of the plates are given by page numbers followed by an "a," e g., 39a. The Bibliography and the Statistical Appendix have not been included in the index. Several lists of maps and graphs have been placed ahead of the alphabetical index for greater convenience. These lists should facilitate the comparative study of maps and charts.

The aim of the authors has been to make the index as complete as necessary but to do so without overloading it with uninformative and repetitive references. The names of places referred to in Part Three have not been indexed unless the reference provides information not available in Part Five. Likewise products referred to in Part Five have not been listed unless the reference adds some significant fact to the material already presented in Part Three

MAP AND PROJECTION SUPPLEMENT

by G. Etzel Pearcy

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University of Missouri

FROM THE first broad plan of a military campaign to the peace treaty, maps occupy a prominent role in all phases of war Bombs are "dropped" many times on a map with fingertip or pencil point before they actually hurtle toward an objective. A supply line progresses along innumerable yards of map before ships and transport planes actually shuttle their cargoes of troops and matériel toward a war zone. Tanks and artillery are distributed on maps before they are deployed in the field. Hence maps are as essential a part of the army's equipment as rangefinders and observation planes.

In this study maps are divided into three groups:

1. Maps suitable for aerial navigation, which stress distance, direction, and landmarks
2 Maps suitable for planning such aspects of military campaigns as engineering operations, troop movements, and the routing of supplies
3 Maps of interest to all military personnel. These maps show the distribution of roads, railroads, products, climate, terrain, and vegetation—all factors important to the various arms of the service.

Projections for Aerial Navigation

Map projections are necessary because it is impossible to reproduce exactly the *curved* surface of the earth on a *flat* piece of paper (see text,[1] p. 29). By using projections maps may be constructed which are absolutely accurate in one or two respects. Features which may be especially desirable on maps are: a constant distance scale, equal area (correct comparative size throughout the map), compass directions running in straight lines, no distortion of shape, and meridians that cross parallels of latitude at right angles (as they do on the globe). All projections show accurately one or more of these features at the expense of others, or they represent a compromise, with no features abso lutely accurate yet none in great error. Each use of maps calls for accuracy or near-accuracy in some feature or features Obviously, a variety of projections is essential because of the variety of uses to which maps are put.

Map projections recommended for aerial navigation are limited to four prevailing types, each of which has special advantages for specific uses.

1. **Mercator's Projection.** A description of this projection and its construction is given in the text, pages 29-31. For aerial navigation its advantages are as great as for marine navigation. Because all its meridians are parallel (Fig. I), a straight line will cross all of them at the same angle. A line which crosses meridians at a constant angle is known as a *rhumb line.* A pilot usually flies a course which is a rhumb line, or a series of rhumb lines, because his compass measures course directions in reference to a north-south line. Thus it is convenient to be able to draw a course as a straight line which indicates true direction from one point to another.

Mercator's projection has the disadvantage that its variable scale makes it unsatisfactory for the measurement of distances. This variable scale arises from the fact that meridians of longitude are drawn parallel instead of converging at the poles as they do on the earth. Thus on Mercator's projection, the parallel of 60° is as long as the equator; on the globe it is only half as long. There is, therefore, a twofold exaggeration in distance and a fourfold exaggeration in area on this projection at this latitude. At 80° latitude the exaggeration in distance is about sixfold, in area about thirty-six-fold. If the United States were mapped on a Mercator's projection so that southern Florida had a scale of 8 miles to the inch, the scale near the Canadian border would be less than 5 miles to the inch.

[1] Chapter 4 of the text, Klimm, Starkey, and Hall's *Introductory Economic Geography*, Second Edition, Harcourt, Brace and Company, 1940, should be read before using this supplement.

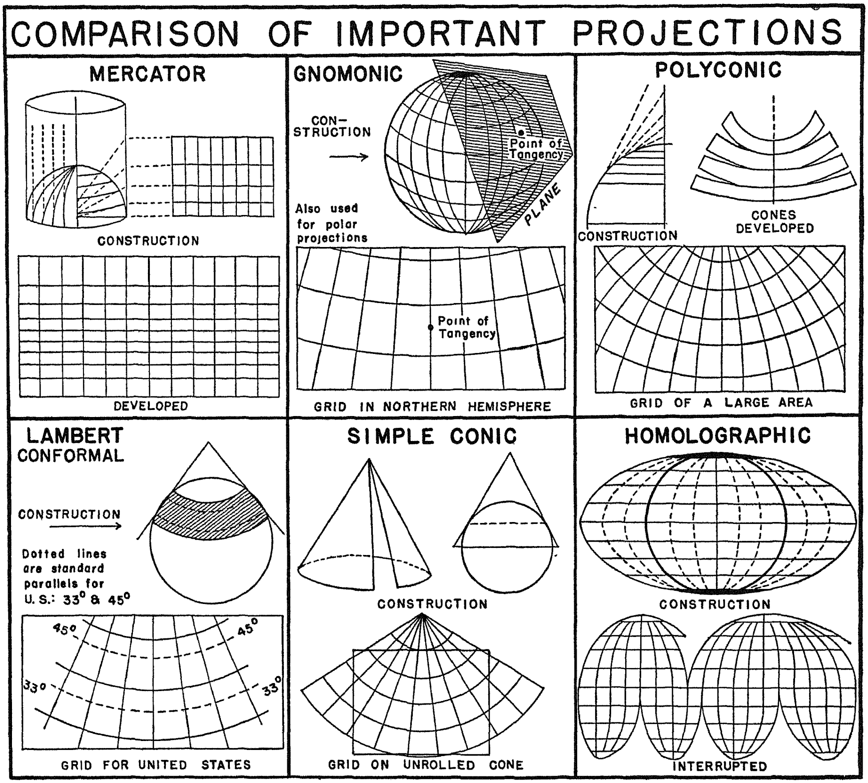


Figure I. Construction and general appearance of six important projections.

2. **The Gnomonic (or Central) Projection.** This projection is constructed by projecting the surface of the globe, from its center, upon a plane. This plane is tangent to the earth at some point on its surface. Under these conditions parallels appear as curved lines and meridians as converging straight lines unless the point of tangency is on the equator (Fig. I). A feature of this projection is that any great circle[1] is shown as a straight line. Also any straight line drawn on this map is a projection of an arc of a great circle. The reason for this is that the point from which the projecting lines originate is the center of the sphere through which the planes of all great circles pass.

Maps on the gnomonic projection may be constructed for any area not larger than a hemisphere by selecting the appropriate point of tangency. The scale on gnomonic maps increases away from the point of tangency.

3. **Polyconic Projection.** The polyconic projection is based on a series of cones, each one tangent to the earth at a different parallel of latitude (Fig. I). Be-

[1] A *great circle* is any circle on the earth's surface whose plane passes through the center of the earth. A great-circle course is a route between any two points along an arc of a great circle which connects them. It is always the shortest distance between any two points on the surface of the earth.

cause of this multiple tangency, a greater accuracy is obtained than is possible in a single-cone (conic) projection (see text, p. 31). The central meridian is a straight line along which the distortion is negligible. All other meridians are arranged as symmetrical curves concave toward the central meridian. Parallels of latitude are arcs of nonconcentric circles which do not cross meridians at right angles (except mid-meridian). Because these arcs are not absolutely parallel, there is a distortion of distances, shapes, and areas away from the central meridian.

The accuracy of the central meridian favors this projection for areas of extended north-south and narrow east-west dimensions, such as the Atlantic and Pacific coasts of the United States. Although possessing in itself no special value for aerial navigation, a great number of maps based on it must be used by aerial navigators

4. **Lambert Conformal Projection.** This conformal (well-shaped) projection is based upon a cone which cuts the earth at *two* parallels of latitude (Fig. I). For United States Aeronautical Charts the parallels selected were 33° and 45° to give a minimum of distortion for the mapped area. This projection is absolutely accurate at the two standard parallels and almost accurate within 10 degrees of either parallel.

Other Projections. In addition to the projections already discussed, two others are of interest to military personnel because of their wide use for showing geographical data: the conic and homolographic projections (see text, pp. 31-32, and Fig. I and Chart I of this Supplement).

Navigation Problems Applied to Projections

The Use of Gnomonic and Mercator's Projections to Plot Great-circle Routes. The shortest course is a great-circle course. Unfortunately the gnomonic projections which show these short courses as straight lines are unsuited for navigation (Fig. II). Inversely, Mercator's projection, which is suitable for navigation, shows a great-circle course as a curved line which is difficult to derive on the Mercator's projection. Frequently, therefore, a course is first drawn (as a straight line) on a gnomonic projection and then transferred onto a Mercator's projection by plotting with reference to the latitude and longitude of points along the course. The resulting course is thus a series of rhumb lines on a projection which accurately portrays compass directions and can therefore be used for navigational purposes.

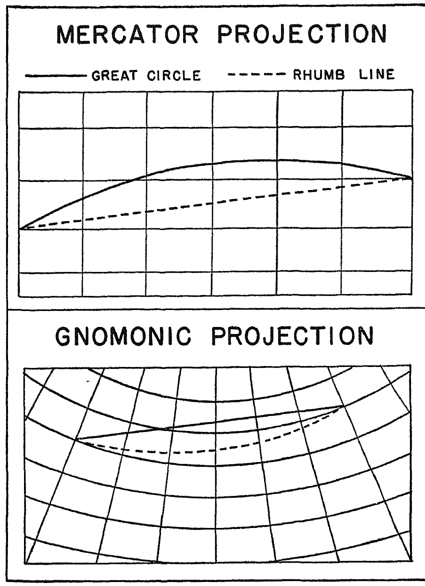


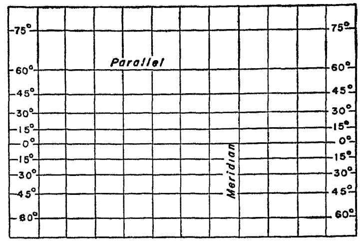
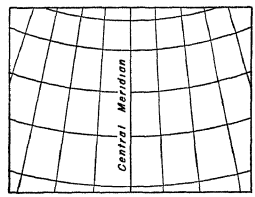
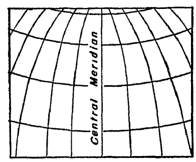
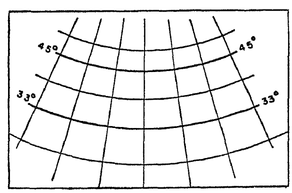
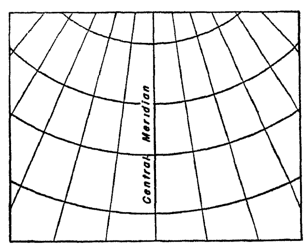
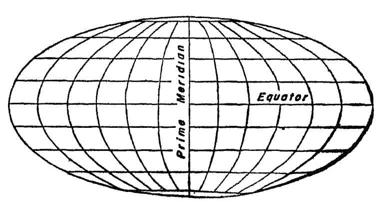
Figure II. Great circles and rhumb lines on two projections important to aerial navigation.

Measuring Courses from Meridians. Meridians must be straight lines in order to insure accuracy in determining course directions from them. Numerous projections have curved meridians; therefore, they are valueless for this purpose. When the Lambert conformal projection is used for navigation, care must be taken to measure any straight-line course from the mid-meridian of the course.

Appearance of Course Lines on Various Projections. A course line which appears in a certain form on one projection does not necessarily appear so on other projections (Fig. II). A rhumb line course will be straight on a Mercator projection, slightly curved on a Lambert conformal projection, and definitely curved on gnomonic and polyconic projections.

Scale Peculiarities of Different Projections. The polyconic and the Lambert conformal projections show scale with relative accuracy. On the Mercator and gnomonic projections exaggeration of distance is enormous, especially if the route covers more than 10 degrees of latitude.

Name of Projection	*Basis of Construction: Parallels and Meridians*	*Advantages*
MERCATOR	Developed from a cylinder tangent to the earth at the equator. Parallels are non-equidistant straight lines. Meridians are all equidistant straight lines at right angles to the parallels.	Any straight line is a rhumb line. All directions are conveniently and accurately shown (parallel with borders of map). Course lines may be easily and directly plotted. All parallels cross all meridians at right angles as on a globe.
GNOMONIC	Developed from a plane tangent to the earth at one point. Parallels and meridians appear as they would be seen from the center of the earth. Parallels curved lines (except equator). Meridians converging straight lines.	The shortest distance between two points on the earth's surface is shown by a straight line (an outstanding advantage).
POLYCONIC	Developed from a series of cones, each one tangent to the earth's surface at a different latitude. Parallels are arcs of non-concentric circles. Meridians curved except central one.	Small amount of distortion. Relatively accurate scale throughout Excellent for areas not having large east-west dimension.
LAMBERT CONFORMAL	Developed from a cone which cuts the earth at two selected parallels (45° and 33° for U. S.) Parallels are arcs of equidistant concentric circles. Meridians are converging straight lines.	Distortion at a minimum. Scale relatively accurate throughout map Straight course lines approach great circle routes. Course directions may be plotted or measured from meridians.
CONIC	Developed from a cone tangent to the earth at one latitude. Parallels are arcs of concentric circles. Meridians are equally spaced straight lines which tend to converge.	An easily constructed projection. Accurate scale and area for small regions. Divisible into sections. Parallels and meridians intersect at right angles.
HOMOLOGRAPHIC	Developed by making equator twice the length of central meridian to show whole world. One hemisphere forms circle in middle and occupies one-half of entire projection. Parallels are straight lines. Meridians curved lines except central one.	An equal-area projection, excellent for showing comparative data. East-west directions are accurate. May be "interrupted" in oceans to give better shapes to continents.

Disadvantages	*Types of Maps for Which Employed*	*Sketch of Projection*
Much distortion and exaggeration of area at higher latitudes. Poles cannot be shown. Scale of miles varies with latitude. Shortest distance (arc of a great circle) between two points not a straight line.	Plotting maps (for air navigation). Coastal navigation charts. Most charts for marine navigation. Maps where direction must be featured, as wind direction. Areas near the equator.	
Accurate only near point of tangency. Scale not constant through map. Directions are apt to be confusing, especially toward outer margins.	Great Circle Charts: For plotting rather than general navigation. Excellent projection for polar areas.	
Both great circles and rhumb lines are usually curved Parallels and meridians do not intersect at right angles Unsatisfactory for measuring course directions.	Not suited to world maps. Basis for most government maps of the United States including those of the U. S. Geological Survey. Formerly used by U. S Coast and Geodetic Survey. May be used as reference maps for navigation purposes.	
A course line does not cross any two meridians at the same angle (mid-meridian of course or course segments used). Course plotted and course made good not exactly the same (rhumb line is a curve).	United States Aeronautical Charts (Sectional, Regional, etc.). Used for areas with considerable east-west extent.	
Inaccuracy increases with distance from line of tangency East-west directions not straight lines.	Many maps of small areas, as individual states of the United States, countries of Europe, or smaller regions. Europe and U. S. are frequently mapped on this projection, but larger areas are impractical.	
Distortion of shape at periphery. Scale is true only along equator. Most meridians not straight lines. When "interrupted" the relationship between continents is partially destroyed.	Excellent for showing geographical data on a world scale: Natural vegetation, climatic regions, soils, relief, agricultural production, distribution of population, etc. The basis for Goode's Homolosine Projection below 40° Latitude.	

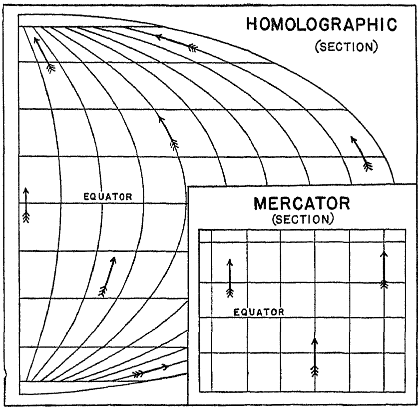


Figure III. Direction on two projections: all arrows point north.

United States Aeronautical Charts

The Lambert conformal projection was selected by the U. S. Coast and Geodetic Survey for official use in aerial navigation in this country Resulting aeronautical charts afford maximum accuracy in both direction and distance. Moreover, navigation problems may be worked out rapidly and efficiently on these charts.

On a map of the whole United States, the amount of scale error is not great, as 90% of its area is represented within one-half of one per cent of absolute accuracy. On a chart of part of the United States, the scale may be considered as correct. Directions, likewise, are satisfactory throughout the map, because all meridians are straight lines running in a true north-south direction Any meridian may serve to measure course directions relative to true north.[1] On the other hand, parallels are curved lines and may not be used in determining course directions.

A straight line on any aeronautical chart approximates a great-circle route. This means that, except for long distances, it may be considered as the shortest route between two points. Chart II classifies and compares the four types of U. S Aeronautical Charts.

Each type of U. S. Aeronautical Chart has a scale which is particularly suited to a specific use, or to the working out of definite navigation problems. The large scale of the Sectional Chart permits ample detail for flights over areas unknown to the pilot or for the most elementary training in flying where frequent reference to the landscape is desirable.

The significance of one inch to 8 miles on the Sectional Chart means more if compared to flight speed Thus, if a training plane flies at the rate of 120 miles per hour, the pilot would be traveling over the chart at the rate of an inch every four minutes. Pursuit planes could cover an inch on the map in one to two minutes. Contour maps with a scale of one inch to one mile would be confusing to pilots because the great amount of detail on them would be passed with insufficient time to utilize it.

For longer flights, the Regional Charts with a scale of one inch to 16 miles prove more satisfactory even though they do not contain so much detail. A flight of several hundred miles means working with a number of Sectional Charts, but probably only one or two Regional Charts.

Trips of great length, including those of continental proportions, may be conveniently planned on the Aeronautical Planning Chart. The Radio Direction-Finding Chart, as the title suggests, is used primarily for plotting radio bearings. The relatively small scale means that numerous radio stations may be shown which would not be within the limits of Sectional or Regional Charts.

Fig. IV shows the amount of detail on the Sectional Chart as compared with that on the Regional Chart Because the scale is halved, the area covered is quadrupled Thus, the number of square miles in the Sectional Chart illustration (with San Antonio) is only one-fourth as many as in the Regional Chart illustration (with Kansas City). The distance between San Antonio and New Braunfels in Fig. IV is approximately 30 miles—about an hour's wartime auto drive, but only a matter of minutes for a plane. With practice, a pilot can learn to read a Sectional Chart sufficiently well to picture the actual landscape as it will appear beneath the plane. On the Regional Chart the detail is much more limited than on the Sectional Chart so that at best it can give only a sketchy picture of the actual countryside.

The aeronautical charts in Fig. IV were greatly simplified for purposes of explanation and comparison. A Sectional Chart would actually include much more area than the illustration; it would be printed in color; and it would contain more detail. Some of its features are as follows:

[1] Actually, the mid-meridian of the course or the mid-meridians of course segments are used because the tendency for meridians to converge toward the north means that any straight line course will cross successive meridians at varying angles.

CHART II. UNITED STATES AERONAUTICAL CHARTS

Name	*Scale*	*Number of Sheets to Cover U. S.*	*Example of Area on One Sheet*
1. Sectional Charts	1. 1:500,000 or 1 inch to 8 miles	1. 87 (fitting evenly)	1. Salina Sheet: About 5/9 of Kansas (northern 2/3 of state west of Topeka).
2. Regional Charts	2. 1:1,000,000 or 1 inch to 16 miles	2. 17 (fitting evenly)	2. 8M: East-west from St. Louis to Kansas-Colorado boundary. North-south from southern Minnesota to south central Missouri.
3. Radio Direction-finding Charts	3. 1:2,000,000 or 1 inch to 32 miles	3. 6 (overlapping)	3. 25 D.F.: East-west from Western Alabama to west central New Mexico. North-south from Kansas-Nebraska boundary to southern tip of Texas.
4. Aeronautical Planning Chart	4. 1:5,000,000 or 1 inch to 80 miles	4. 1	4. Entire United States.

Note: Coastal and boundary areas well shown on marginal sheets which are full-sized instead of being cut off at oceans or international borders

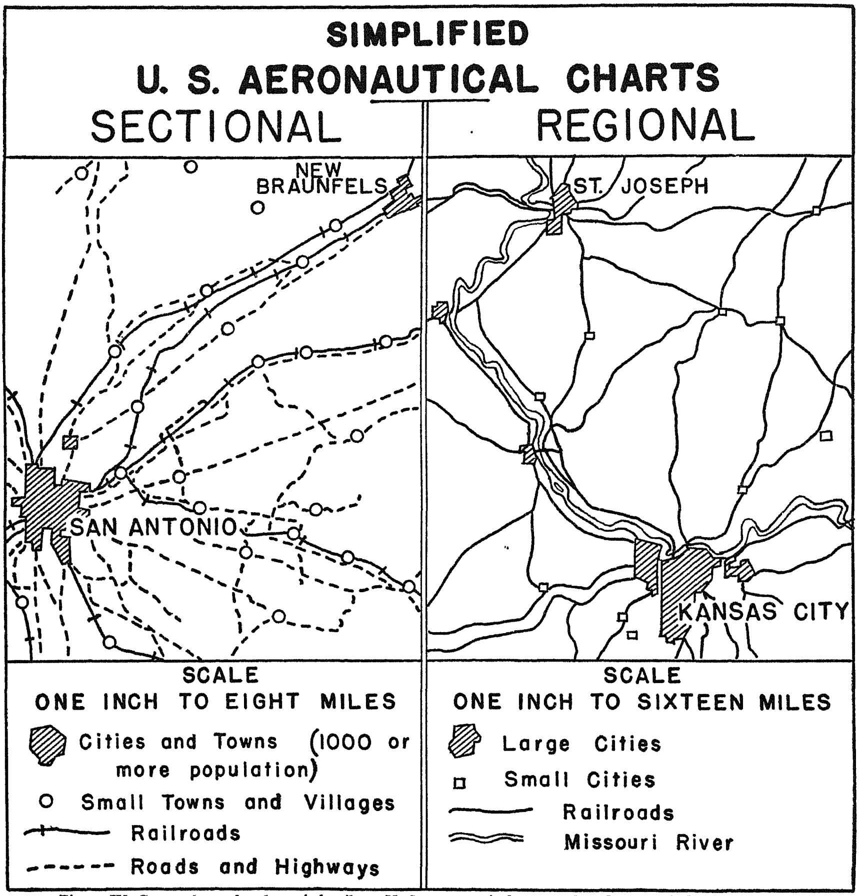


Figure IV. Comparison of scale and detail on U. S. aeronautical sectional and regional charts.

Cities of over 1000 population are shown in yellow, and for those of over 5000 the shape is represented

Highways appear as purple lines, the width of the line denoting relative importance.

Elevation is shown by both colors and contour lines (with never less than 1000 foot intervals) For example, areas between the 1000 and 2000 foot contours are colored light green.

Blue designates water bodies or streams.

Many helpful reference points are printed in black, including such features as race tracks, tall buildings in cities, railroad overpasses, and oil derricks

Superimposed over the map in red are symbols denoting aeronautical features and Federal Aids to Navigation. These include airports, on-course radio beams, isogonic lines, beacons, and civil airways.

While such maps are excellent for providing aeronautical information, they are of little value in analyz-

ing surface conditions. For terrain analysis the large contour interval is disappointing because land forms do not show up in any but the broadest detail.

Other Maps of Aeronautical Value

Magnetic Variation Chart of the United States (Isogonic Chart). In the continental United States magnetic variation of the compass from true north ranges from more than 20° easterly variation in the northwest part of the country to more than 20° westerly variation in northern New England. These differences are represented on the chart by isogonic lines which are smooth lines drawn through all places having the same variation[1] With a scale of 1 7,500,000, or one inch to 115 miles, isogonic lines of 1° intervals may be shown. In addition the annual rate and direction of the variation change is indicated in minutes. The chart employs a conic type of projection whose straight meridians permit easy measurement of the variation from true north.

Great Circle Charts. This chart for the United States, in contrast to most U. S. Aeronautical Charts, is constructed on the gnomonic projection. The scale is similar to the U S. Aeronautical Planning Chart which also covers the United States in one sheet Any straight line will represent a great circle; therefore, the chart is useful for determining precisely the shortest route between any two points. Accuracy of scale and shape is confined to the central point of tangency which is at latitude 40° north and longitude 96° west (between Omaha and Topeka).

Most of the oceans of the world are also mapped on great circle charts. The shortest possible routes across these water bodies there appear as straight lines. Of special interest to American aviation is the Great Circle Chart of the North Atlantic which illustrates the shortest track from our east coast to northwestern Europe. Between New York and London such a track passes over the center of Newfoundland.

Hydrographic Charts. The U. S. Hydrographic Office publishes charts of areas outside the limits of continental United States, many of which are of interest to American aviators. While these charts are not prepared primarily as aeronautical charts they may serve as such in areas for which no better maps are available. In addition the Hydrographic Office has prepared strip aviation maps covering areas in the Caribbean Region, Alaska, and the Hawaiian Islands, based on Mercator's projection. The Hydrographic Office concerns itself primarily with charts of foreign areas. Similar charts for the United States and its possessions are published by the United States Coast and Geodetic Survey.

1 The isogonic line along which true north coincides with compass north is called the agonic line.

Maps Useful in Ground Operations

Military strategy on the ground demands specific types of maps to work out the necessary procedure for analyzing enemy positions, moving troops and matériel, and planning operations. Unlike aeronautical charts, military maps emphasize land forms and therefore must be on a larger scale. Many of the world's strategic areas have literally been mapped foot by foot. The Ordnance Survey of Great Britain published topographic maps of that country as early as 1801, and since that time has completed surveys on scales as large as 25 inches to the mile. In this country the United States Geological Survey is responsible for topographic maps which could also serve military operations. For many areas, however, the best available maps show much less detail than military commanders desire.

The usual scale of U. S topographic maps is 1 62,500 or about one inch to one mile. However, either larger or smaller scales are used in some instances. Contour intervals[2] range from 5 to 200 feet, depending upon the nature of the area mapped. In the Sierra Nevada and Rocky Mountains, slopes are steep with elevations up to and over 14,000 feet, while on the delta of the Mississippi River slopes may be as gentle as 4 inches to the mile. Obviously different contour intervals must be used to fit such different degrees of relief.

Fig. V represents an area of approximately 4¼ square miles in order to show clearly the topographic detail. The scale is exceptionally large, permitting more accurate measurement and allowing space for plotting. In fact, the War Department recommends topographic maps with a scale of 1:20,000, or slightly over 3 inches to one mile, and a normal contour interval of 20 feet. A number of possible observations can be made of the area mapped in Fig. V as follows:

GENERAL

Scale. 1:23,760, or about 2⅔ inches to one mile (derived from graphic scale on map).
Contour Interval 20 feet.
Relief. An elliptical hill is in the west central part of the map, and the west end of a ridge or hill near the

2 Contours and contour intervals are discussed on page 25 of the text.

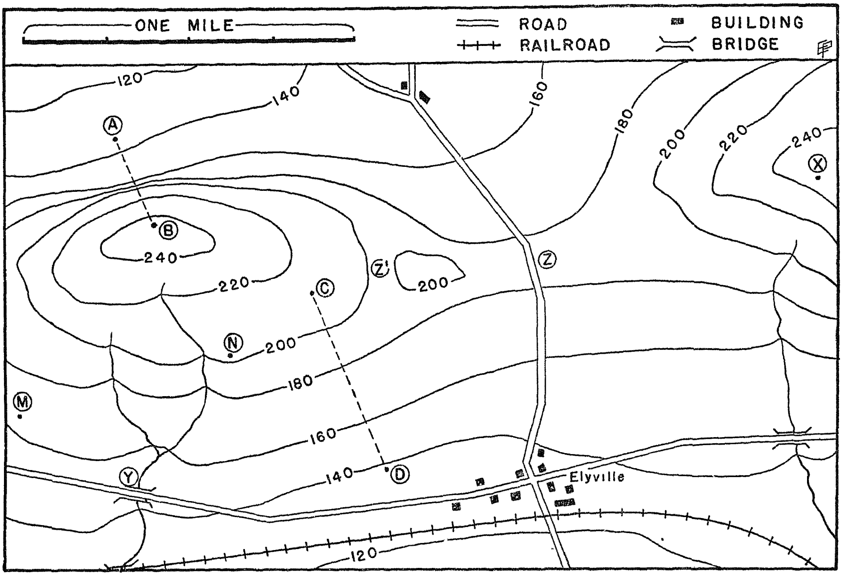


Figure V. Large scale contour map.

northeast corner. A gentle slope occurs along the southern margin, possibly the northern part of a stream valley.

Notes on contour lines: A contour line can never end, but closes on itself. Obviously, contour lines end abruptly when they reach the edge of the map, but their continuance is implied. Contours are always at right angles to slope. One contour can never branch out of another, regardless of the type of relief Moreover, contour lines cannot cross except in the rare case of an overhanging cliff If contours coincide, a vertical cliff is designated. The behavior of contours is the keynote to relief.

ELEVATION

Exact Elevation. The elevation of any point on a contour line is determined by merely noting the value of the contour Thus, a point on the 200 foot contour is 200 feet above sea level.

Approximate or Computed Elevation. The elevation of points between contours may be computed with a reasonable degree of accuracy by relating them to the distance from the contour lines on either side. The point marked (M)[1] on Fig. V is about $\frac{4}{20}$ of the way from the 160 foot contour toward the 180 foot contour, so its elevation would be approximately 164 feet This system works most effectively where the relief appears regular, i e, when there is a more or less uniform spacing between successive contours Sometimes, however, the general nature of the surrounding relief must be taken into account in determining an elevation not on a contour line. Point (B) may not have its elevation determined as was point (M) for there is no 260 foot contour to which it may be related. It is unlikely that the relief exceeds 240 feet by more than 5 or 6 feet; consequently (B) may be estimated to have an elevation of approximately 242 feet because of its relation to the 240 foot contour.

Relative Elevation. Relative elevations on the map may also prove useful If point (B) is 242 feet above sea level, it would also be approximately 110 feet higher than the crossroads at Elyville near the southern margin of the map (Elyville computed as 132 feet above sea level) The horizontal distance between (B) and Elyville is 1$\frac{3}{8}$ miles. Thus, if Elyville were occupied by troops and an enemy position were known to be at (B), proper range of fire could be computed.

SLOPE

Gentle Slope The dotted line extending from point (C) to point (D) represents a relatively gentle slope with a general southerly exposure. The contours crossed by the dotted line are fairly evenly spaced, which means that the degree of slope changes but little. (C) has an elevation of 211 feet and (D) 138 feet, so the vertical difference between them is 73 feet. The same two points are 2970 feet ($\frac{9}{16}$ miles) apart horizontally, which means that there is one foot of vertical difference to 40 7 feet of horizontal distance (2 45% grade). In comparison the steepest grade on the road north

[1] Encircled letters in Fig. V are for reference purposes in analyzing the map.

of Elyville is only 1.75%. Such computations might well be necessary to determine whether or not it would be practical to take military equipment off regular roads and proceed cross-country.

Steep Slope. The slope represented by a dotted line from point (A) to point (B) is not only considerably steeper than the one from (C) to (D), but it varies in degree of slope (A) and (B) are 1450 feet apart with a vertical difference of 104 feet. This represents an average slope of about one foot vertical ascent to 14 feet of horizontal distance (7% grade). But this slope has a relatively gentle gradient between the 140 and 160 foot contours while between the 180 and 200 foot contours the vertical ascent is one foot for each 2.75 feet of horizontal distance (36 4% grade).

PHYSICAL FEATURES

Saddles. Relatively low places on a ridge are known as *saddles,* or *passes* if the break between elevations is narrow (Z) is an elongated saddle between the heights marked (B) and (X). The road running north from Elyville passes over this low divide connecting the two low areas on the map (Z) is a smaller saddle between the height marked (B) and the hill immediately to the east, circled by the 200-foot contour.

Streams No important streams appear on the area mapped, but several tributaries flow down the southern slopes of the two large hills. Contours pointing upstream denote the valleys of streams.

VISIBILITY

On a contour map it is possible to determine whether or not a position, route, or area is visible from a given point This aids in the choice of observation points and allows a commander to tell whether troops on a given road can be seen from an enemy position. There are several methods of determining visibility, of which the inspection method will be illustrated below The basic rules for determining intervisibility are:

1. The points, if on opposite sides of a valley and located well above the intervening ground are intervisible. In Fig. V are (X) and (Z′) intervisible? (X) and (C)?
2. If there is a feature between two points which is higher than both, they are not intervisible Are (Z′) and (Z) intervisible?
3. If there is a feature between the two points which is higher than one but not higher than the other, the points may or may not be intervisible Can (Z′) be seen from (X)?
4. If the slope of the ground between the two points is convex, they are not intervisible. Can (D) be seen from (B)?
5. If the slope of the ground between the two points is concave, they are probably intervisible.
6. When the ground between the two points is level, their intervisibility depends on the presence of vegetation and the works of man.

CULTURAL FEATURES

The works of man which appear on maps are called *cultural features* or *culture.* Often they are of as great military importance as relief features. In Fig. V, the crossroads at Elyville, the buildings in which military stores or personnel may be housed, the bridges which must be protected, and the railroad along which supplies may move are all of interest to the soldier

Map Symbols. The student using military maps should be sure to observe the legends usually printed at the bottom or sides of the map which indicate the meaning of any special symbols peculiar to that map. All military personnel having anything to do with maps should become familiar with the War Department's Basic Field Manual FM 21-30, *Conventional Signs, Military Symbols, and Abbreviations* (Superintendent of Public Documents, Washington, 1941).

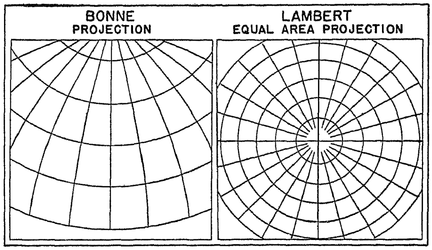


Figure VI. Latitude and longitude grid of two projections frequently used.

Military Grid Systems. To facilitate the reading of military maps, a grid system is overprinted thereon. The grid consists of a series of horizontal (approximately east-west) lines known as X-grids and vertical (approximately north-south) lines known as Y-grids. These are spaced 1000 yards apart (on European maps 1000 meters apart). These lines are numbered in one series from left to right, and in another series from bottom to top. The combination divides the map into 1000-yard (or meter) squares known as the military grid. Any position on the map can be indicated by giving the numbers of the two grid lines that form the beginning of each square. Thus a place located at the crossing of 60 north-south grid line and 11 east-west grid line would be identified simply as 60-11 (or often just 6011) If a more exact location is wished, a fractional reading may be added, for example, 60.2-11.4 (usually abbreviated 602-114 or just 602114). The space indicated by this last reading is a square, 100 yards on each side, within which it is relatively easy to find the feature to be located.

Methods of Showing Relief Other Than by Contours

Hachures. Hachures represent relief in a manner more graphic than contours, but they are less precise (see Fig. 16 in the text) The direction, length, width, and spacing of hachure lines all combine to give a vivid impression of the nature of relief. For

example, short heavy lines closely spaced denote an abrupt slope, while conversely, longer, fine, open-spaced lines show gentle gradients. With a little practice, students may thus learn to "picture" mentally relief as it is shown on hachure maps. Lacking means of definite measurement of elevation, hachure maps frequently depend upon spot heights (elevations printed in various places on the map, such as on hills and at towns or villages). The maps of much of Europe, including France and Germany, use the hachure technique. In many of them contours are superimposed on hachures to combine the advantages of both.

Physiographic Diagrams. Throughout the regional part of the text are examples of physiographic diagrams, as of eastern United States (p. 326), Mediterranean Region (p. 416), and China (p. 441). Note that this method of showing topography is usually limited to large areas (small-scale maps) because the principal purpose of the technique is to give a general impression of relief. For example, on page 392 of the text observe the symbols in the Alps of Switzerland, southeastern France, and northern Italy. Obviously there are more peaks in the Alps than are shown, and those that appear on the map do not necessarily coincide with actual peaks. Nevertheless, the symbols show the type of mountains in the region and present the broader aspects of the relief there. Likewise, plateaus, old worn-down mountains, ridges, valleys, and other land forms can be shown on the physiographic diagram.

Layer Maps. Layer maps, also called hypsometric maps, are merely contour maps with colors between individual contours to set off gradations of elevation. The contour interval must necessarily be great or the map will resemble a crazy-quilt. The U. S Aeronautical Sectional and Regional Charts are examples of layer maps. Both wall and atlas maps for school use are frequently of this type also. The general nature of elevation and relief on a continental scale is excellently presented in this manner.

Maps of General Use and Their Projections

A single atlas or geography may contain several hundred maps including 20 or 30 different types and 10 or more projections. The reasons for this diversity of maps may be summarized as follows:

1. **Different Kinds of Data to Be Shown.** Within reason, almost anything that exists on the face of the earth can be mapped. Geologists are interested in the distribution of rock types, business men look at maps showing marketing areas; and ornithologists make maps showing the distribution of bird life. Select ten maps at random in the text and note the variety of data mapped.

2. **Scale.** The area included within a map may be the whole world or a small region, and each may be on a sheet of paper of the same size. The difference arises from difference in scale (see p. 25 in text). Maps are classified by scale as follows:

1. Small scale Maps of small scale, varying from 1:1,000,000 to 1:7,000,000, are used for general planning and for strategical studies by the commanders of large units.

2. Intermediate scale. Maps of intermediate scale, from 1:200,000 to 1:500,000, are required for planning operations, including movements, concentration, and supply of troops Maps of a scale of about 1:250,000 are particularly suitable for planning movements of armored forces and for use as maps of maneuver areas.

3 Medium scale. Maps of medium scale, from 1:50,000 to 1:125,000, are needed for strategical, tactical, and administrative studies by units ranging in size from a corps to a regiment The U. S. Geological Survey maps on a scale of 1:62,500, with wooded areas and road classifications added, have been found especially suitable for these purposes During a campaign, these maps may be used at this scale or they may be enlarged or reduced according to existing needs and areas.

4 Large scale Maps of large scale, normally not greater than 1:20,000, are intended for tactical and technical battle needs of the field artillery and the infantry For city plans scales as great as 1 5,000 may be desirable

3 **Relation of Projection to Region.** The need for fitting the projection to the size and shape of the region as well as to the nature of the data to be mapped has resulted in certain common (but not invariable) relations between world areas and the projections used to map them. These are summarized below.

The World and the Hemispheres. The difficulties inherent in constructing a world map have already been discussed in Chapter 4 of the text and earlier in this Supplement. Almost any projection (except the conic and gnomonic projections) may be used for a world map and be satisfactory for some purposes. The rectangular projections (such as Mercator's) are useful for showing relative location (except in the higher latitudes) and direction, but they have poor shapes and a variable scale The equal-area projections (such as those on the inside covers of the text) give good shapes to the continents and allow distances to be measured with approximate accuracy but may be confusing as to directions and relative locations among continents. Some projections attempt to combine these advantages by having meridians which tend to converge (thus giving less distortion of area) but which

do not completely converge (thus preserving relatively good shape at the periphery). Van der Grinten's projection, Fig. 69 in the text, is an example.

When looking at a globe, a person sees one-half of it, or a hemisphere. As a result, hemispherical projections appear more realistic than those of the entire world A plane through the center of the earth, or tangent to its surface, may have the latitude and longitude grid projected upon it in a number of ways to give a projection for a hemisphere. The hemisphere maps on page 37 in the text are examples.

The United States. The conic and polyconic projections are commonly used for mapping the United States.[1] The student may easily distinguish the conic from the polyconic by noting whether the meridians are straight (conic) or curved (polyconic) lines. When sections of the United States, such as single states or groups of states, appear on these projections the *central meridian of the area mapped,* rather than that for the country as a whole, should be perpendicular to the north and south borders of the map (see text, p 347). This prevents the map from seeming tilted. North America extends over such a wide range of latitude that the polyconic rather than the conic projection insures greater accuracy, although the Lambert azimuthal equal area projection (Fig. VI) obtains similar results.

Caribbean Area. Lands in and surrounding the Caribbean Sea are all at latitudes sufficiently low to enable the use of Mercator's projection with satisfactory results. The reference map of Central America on page 110 of the text is one such example. The polyconic projection is frequently used when the map extends northward to include a portion of the United States, or where there is a stress on areal comparison (as on the physical map in the text, p 363) Maps showing fragments of the Caribbean Region, such as the Mexican Plateau or Puerto Rico, may employ almost any projection with little error.

Europe. Most maps of Europe, whether of the entire continent or only a part of it, use the conic projection. (Note the three regional maps of Europe in the text, pp. 392, 408, and 416.) Most popular atlas and "war zone" maps of Europe also show the telltale straight converging meridians and curving parallels. In some instances the polyconic projection is used, as in the case of the reference map of Europe on page 250 in the text.

Asia. The enormous latitudinal and longitudinal extent of Asia creates a problem in accurate mapping.

[1] U. S Aeronautical Charts and some other special-use maps are exceptions to this.

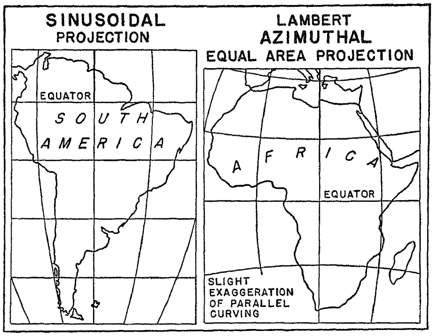


Figure VII. Common Southern Hemisphere projections.

Both the Bonne and the Lambert azimuthal equal area projections show Asia to advantage with curving meridians which minimize poor shape as well as areal exaggeration in high latitudes

The Bonne projection is a modification of the polyconic projection, the chief difference being that correct distances are measured along each parallel instead of along only one. The result is the emphasized concavity of all meridians except the central one, as illustrated by the reference map of Asia on page 468 of the text (also Fig. VI of this Supplement).

In a Lambert azimuthal equal area projection, the area to be mapped is deployed as upon a plane tangent to the central point of the area selected. Parallels and meridians (except the one in the center) are curved according to mathematical computation, giving excellent shapes to large land masses. On page 283 of the text there is a map of Asia showing this projection.

South America and Africa. Fig. VII shows the two projections commonly employed for mapping South America and Africa on a continental scale. The Lambert azimuthal equal area projection was discussed under Asia.[2] The sinusoidal projection (also called Sanson's projection) is particularly adapted to South America and Africa (see text, pp. 118, 372, and 475). On it areas are correct, shapes of land masses excellent, and distances accurate along all parallels and the central meridian. Parallels are straight lines while meridians are sine curves, which give the projection its

[2] Although the Lambert azimuthal equal area projection is difficult to construct, mathematical tables somewhat simplify the process. It has the advantage of being adaptable to many areas, and in all cases keeps the scale error down to an insignificant amount.

name. Either continent may be mapped on either projection.

On Fig. VII these projections are applied to a continent. They are easily distinguished from each other by observing whether or not the parallels are straight or curved. Check available wall or atlas maps of South America and Africa for further practice in identification of the two projections.

Australia and Oceania. No projection stands out as being especially superior for Australia. The Bonne, sinusoidal (see text, p. 463), and Lambert azimuthal equal area projections are all used. The continent is also small enough to be mapped on the conic projection while its relatively low latitude also allows Mercator's projection to be used (see text, p 460). When Australia is included as a part of Oceania, the Lambert azimuthal equal area projection becomes a favorite because of the enlarged areal extent of the map.

Oceans. The desirability of straight-line courses and true angles favors Mercator's projection. A homolographic type gives better shapes to the ocean basins, but distorts their bordering coastal lands. Just as a homolographic projection may be interrupted in the ocean to give better shapes to continents, so may the continents be interrupted to the advantage of the oceans.

Polar Areas. By holding the globe so that the North Pole is in the center of the visible hemisphere, it will be seen that the meridians radiate from a common center and parallels appear as a series of concentric circles, appearing closer together as the equator is approached. Some of these projections cannot include a complete hemisphere, while others may be extended to include more than one hemisphere. Obviously, directions are vastly different on a polar projection than on other types. For example, a straight line passing through the pole reverses its *compass direction* in doing so. The gnomonic, homolographic, sinusoidal, and Lambert equal area projections, when used for polar maps, all have roughly similar patterns The last is illustrated in Fig. VII.

Maps on these projections illustrate trans-polar flying routes. Recent news and pictorial magazines and Sunday newspaper supplements frequently feature these theoretical air routes over polar lands and the great distances to be saved by using them. Note that these routes all follow great circles.